EXISTING SYSTEM EVALUATION

This chapter evaluates the existing system to identify system constraints and inefficiencies that should be resolved for optimal system operation and preparation for future system expansion. This chapter consists of the following five sections:

- Hydraulic Analysis
- Storage Analysis
- Pump Analysis
- Energy Analysis
- Water Quality Analysis

Where appropriate, recommendations are made for addressing system deficiencies or improving system performance. Capital cost estimates are provided for each recommendation. The chapter concludes with a summary of system inspection requirements. A detailed description of the existing system is included in Chapter 2.

8.1 HYDRAULIC ANALYSIS

A hydraulic analysis was performed on the existing system for Minimum Day Demands (MinDD), Average Annual Demands (AAD), and Maximum Month Demands (MMD). Diurnal curves that included peak hour demand were used to account for the variation of demand throughout the day for the MinDD, AAD, and MMD scenarios. System analysis criteria are discussed in Chapter 7 and are summarized in Table 8.1.

Figure 8.1 shows locations with pressures exceeding 125 psi. Figure 8.2 shows locations with low pressures below 60 psi and pipes with velocities and head losses exceeding the stated criteria in Table 8.1.

8.1.1 Distribution System

Using the hydraulic model, the distribution system was evaluated under MinMD, AAD, and MMD demand conditions. The model predicted both high and low pressure deficiencies under the evaluated conditions.

Table 8.1	**System Evaluation Criteria** Recycled Water Master Plan Carlsbad Municipal Water District		
Parameter	**Evaluation Criteria**		**Demand Condition**
System Pressure			
Minimum System Pressure	60	psi	Peak Hour Demand
Maximum System Pressure(1)	125	psi	Minimum Hour Demand
Maximum System Pressure(2)	150	psi	Minimum Hour Demand
Pipeline Velocity			
Evaluation of Existing Pipelines:			
Max. Velocity	7	ft/s	Peak Hour Demand
Sizing of New Pipelines:			
Max. Velocity (Diameter > 12-inch)	5	ft/s	Peak Hour Demand
Max. Velocity (Diameter ≤ 12-inch)	7	ft/s	Peak Hour Demand
Pipeline Head Loss			
Evaluation of existing pipelines:			
Max. Head Loss	7	ft/1,000 ft	Peak Hour Demand
Sizing of new pipelines:			
Max. Head Loss	5	ft/1,000 ft	Peak Hour Demand

Notes:
(1) Maximum pressure without pressure reducing valves; higher pressures are acceptable if pressure reducing valves are installed at the meter connection (CPC, 2007).
(2) Maximum pressure for standard pipelines. For areas with higher pressures, the pipeline class (pressure rating) should be considered.

Areas exceeding the 125 psi criteria are shown in Figure 8.1 by maximum pressure. As shown in the evaluation criteria in Table 8.1, the maximum pressure was evaluated under MinMD conditions and consisted of two criteria, a 125 psi maximum above which service lateral pressure regulating devices should be considered and a 150 psi maximum above which consideration should be made for higher pipeline pressure classifications during design. Note that junctions that are a part of facilities (e.g., discharge headers for pump stations) were excluded from this analysis and are not shown as deficient.

Approximately 35 percent (by demand) of the system exceeds the maximum pressure criteria of 125 psi. Approximately 7 percent (by demand) of the system exceeds the second maximum pressure criteria of 150 psi, and the associated pipelines should be designed accordingly for higher pressures.

Low-pressure deficiencies were also identified. Areas with pressures below 60 psi are shown on Figure 8.2. The majority of the low pressure deficiencies are not located near pipelines with velocity or head loss deficiencies, indicating that low pressures in the system are predominantly due to higher elevations within the existing pressure zones, rather than localized head loss due to pipeline velocities during periods of high demand.

Legend

Nodes with High Pressures

- 125 - 150 psi
- 151 - 175 psi
- 176 - 200 psi

Facilities

- Meter
- Pump Station
- Pressure Regulating Station
- WRF
- Tank
- Reservoir

Recycled Water Pipelines

Diameter

- Less than 6"
- 6" to 8"
- 10" to 14"
- 16" and larger

Other

- Freeways
- Major Roads
- Local Streets
- Carlsbad Municipal Water District Boundary
- Water Body
- Carlsbad City Limits
- San Diego County

0 5,000 10,000 Feet

Figure 8.1
Pressures Greater than 125 psi
Carlsbad Municipal Water District

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Figure 8.2
Low Pressure and High Velocities
Recycled Water Master Plan
Carlsbad Municipal Water District

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The hydraulic model predicted head loss and velocity deficiencies at a total of 16 locations, which are shown in Figure 8.2. In addition, head loss or velocity were predicted to exceed criteria in pipelines at two locations which are a part of facilities. These pipeline segments were identified at the Calavera Pump Station hydropneumatic tank and the discharge pipeline from Meadowlark WRF. Since high head loss could be expected at each of these locations, these segments were excluded from analysis.

Head loss and velocity deficiencies in 11 locations were along pipelines serving only one customer. These deficiencies were evaluated on a case-by-case basis. It was determined that the model predicted that pressure was reduced below the minimum pressure criteria of 60 psi at the point of connection at only one location, the Park Hyatt Aviara Resort. Pressure at the meter was predicted to fall to 42 psi under AAD conditions and 29 psi under MMD conditions. It should be noted that the assumed diurnal pattern for the Park Hyatt Aviara Resort may be different during MMD conditions, with irrigation taking place over a longer portion of the day. Since this is one of CMWD's largest and most long-term users, it is likely that any problems with low pressure would have already been brought to CMWD's attention. However, recommendations for two of the deficiencies discussed below are anticipated to improve the pressure at this location.

Three locations of high head loss, indicated as C, D, and E on Figure 8.2, were located away from areas of low pressure and are assumed to have limited impact on the system and not recommended for replacement at this time. However, if one of these pipes should require replacement due to normal maintenance, then the new pipe should be of a larger diameter.

The locations of the remaining two deficiencies are along Aviara Parkway. These two deficiencies are listed in Table 8.2 and identified on Figure 8.2 by the corresponding Map IDs A and B.

Table 8.2 Pipeline Deficiency Locations
Recycled Water Master Plan
Carlsbad Municipal Water District

Map ID	Street	From	To	Zone	Exist Diam. (in)	Repl. Diam. (in)	Length (ft)	Low Pressure Nearby
A	Aviara Pkwy	300' s/o Poinsettia Ln	Kestrel Dr	384	6	12	1,100	Y
B	Aviara Pkwy	300' nw/o Black Rail Ct	Four Seasons Pt	384	12	16	1,100	Y

As shown in Table 8.2, a total of 2,200 feet of pipeline along Aviara Parkway is predicted, at least in part, to cause pressure losses in the area. While velocity in these stretches of pipeline reach a maximum of 6.3 ft/s under peak hour demand (PHD) conditions, head loss reaches 13 feet per thousand feet, with total head loss over the deficient pipeline segments of 25 feet (10.8 psi). It should be noted that, according to the City's GIS pipeline layer, the diameters in the entire 4,200-foot stretch of pipeline along Aviara Parkway from Poinsettia Lane to Four Seasons Point range in diameter from 6 inches to 14 inches, transitioning in diameter four times over this stretch before connecting to the 14-inch pipeline extending east from Four Seasons Parkway. Note that much of this stretch was constructed in 1989.

A pressure drop of 10 psi under PHD conditions is not significant enough to warrant replacing the pipeline segment. If CMWD experiences low-pressure problems in the system in this area under high demand conditions, especially as demands increase as the system is expanded, replacement of this section may assist in resolving low-pressure problems. Also, if one of these pipeline segments should require replacement due to normal maintenance, then the new pipe should be of a larger diameter.

The deficiencies identified in Table 8.2 are shown in Table 8.3 along with the pipeline segments, which have less significant effects on the system. Model predictions under AAD conditions are also presented for reference.

Table 8.3 Pipeline Deficiencies Under Demand Conditions
Recycled Water Master Plan
Carlsbad Municipal Water District

Map ID	Zone	Length (ft)	Demand Condition	Maximum Head Loss (ft/kft)	Maximum Head Loss (ft)	Max Velocity (ft/s)	Exist Diam (in)	Par.[1] Diam (in)	Repl.[2] Diam (in)
A	384	1,100	AAD	5.9	6.3	2.9			
		1,100	MMD	12.6	13.5	4.4	6	8	12
B	384	1,100	AAD	6.4	5.4	4.7			
			MMD	11.2	10.9	6.3	12	8	16
C	384	1,300	AAD	8.6	9.5	3.9			
			MMD	10.5	11.8	4.4	8	8	12
D	384	500	AAD	3.2	1.4	2.5			
			MMD	8.9	4.1	4.3	8	8	12
E	660	2,200	AAD	2.7	5.2	2.3			
			MMD	8.1	15.4	4.1	8	8	12

Notes:
(1) Parallel
(2) Replacement

As previously mentioned, since pipeline deficiencies C, D, and E are not located near pressure deficiencies, it is not recommended to replace these pipeline segments. Pipelines A and B contribute, in part, to low pressures in the area. However, the level of head loss associated with pipelines A and B does not warrant replacement at this time. Recommended diameters for any potential replacement or paralleling of pipelines are included in Table 8.3.

8.2 STORAGE CAPACITY ANALYSIS

The storage analysis evaluates if CMWD's existing storage capacity meets the evaluation criteria for operational and emergency as described in Chapter 7. A definition for each category of storage criteria is summarized below.

- Operational Storage: The storage required to buffer demand fluctuations under maximum day demand (MDD) conditions. The required operational storage is defined as 33-percent of MDD.
- Short-term Emergency Storage: The storage volume required to prevent a reservoir from completely draining during an emergency situation such as a temporary supply outage or a demand spike. The required emergency storage is defined as 17 percent of MDD.

For this analysis, it is assumed that MDD conditions will be similar to MMD conditions.

The existing system storage facilities are summarized in Table 8.4. Storage for Zones 580 and 318 are provided by reservoir capacity in Zone 384, and storage for Zone 660 and 550 is provided by Mahr Reservoir. It should be noted that the Calavera hydro-pneumatic tank and Bressi hydro-pneumatic tank are not listed in this table, as they are not intended to provide storage. As will be discussed in Section 8.3, Zones 580 and 660 will not have storage if power is not available at the Bressi and Calavera Pump Stations.

Table 8.4 Summary of Storage Facilities by Pressure Zone
Recycled Water Master Plan
Carlsbad Municipal Water District

Reservoir	Zone	Volume (MG)
Twin D Tanks	384	2.5
C Tank	384	1.0
Mahr Reservoir	550	32.0[(1)]
Total Storage		**35.5**

Note:
(1) CMWD is only allotted 32 MG of the 50 MG capacity of the Mahr Reservoir. The remaining capacity is allocated to the Olivenhain Municipal Water District.

As shown in Table 8.4, CMWD has a total of 35.5 MG of storage. 32 MG of this is associated with Mahr Reservoir, located in Vallecitos Water District's (VWD) service area. While Mahr Reservoir is used to provide operational and short-term emergency storage for CMWD's system, CMWD does not typically replenish the reservoir with recycled water from Carlsbad WRF, and Meadowlark WRF is therefore the only source of replenishment for the reservoir.

At this time, daily demands in Zone 550 and 660 are much less than the daily supply from Meadowlark WRF, so CMWD has some flexibility in its use of Mahr Reservoir for operational and short-term emergency storage. As demands increase in Zones 550 and 660, CMWD will be limited in its use of Mahr Reservoir as storage unless CMWD replenishes the reservoir from Carlsbad WRF. Operational and short-term emergency storage requirements that were calculated based on the evaluation criteria discussed above are presented in Table 8.5. This table also shows a comparison of these requirements with the existing storage capacity. It should be noted that storage analysis is not conducted for Gafner WRP since operational storage is provided by the La Costa Golf Course through on-site ponds.

Table 8.5 Storage Capacity Evaluation
Recycled Water Master Plan
Carlsbad Municipal Water District

Zone	MMD (mgd)	Required Operational Storage(1,2) (MG)	Required Short-Term Emergency Storage(1,3) (MG)	Total Required Storage (MG)	Existing Storage (MG)	Balance (MG)
660	0.48	0.16	0.08	0.24	0.0(4)	-0.24
550	1.06	0.35	0.18	0.53	0.0(4)	-0.53
Subtotal		***0.51***	***0.26***	***0.77***	***0.0***	***-0.77***
Subtotal w/ Mahr		***0.51***	***0.26***	***0.77***	***32.0(4)***	***+31.2***
580	0.35	0.12	0.06	0.18	0.0	-0.18
384	3.61	1.19	0.61	1.80	3.5	+1.70
318	0.06	0.02	0.01	0.03	0.0	-0.03
Subtotal		***1.23***	***0.68***	***2.01***	***3.5***	***1.49***
Total w/o Mahr	**5.56**	**1.84**	**0.94**	**2.78**	**3.5**	**+1.49**
Total w/ Mahr	**5.56**	**1.84**	**0.94**	**2.78**	**3.5**	**+32.69**

Notes:
(1) Operational and Emergency Storage requirements are based on the evaluation criteria from Chapter 7.
(2) Based on the evaluation criteria, Operational Storage is 33 percent of the MMD.
(3) Based on the evaluation criteria, Emergency Storage is 17 percent of the MMD, or four hours.
(4) Supplies from Meadowlark WRF are taken at a constant rate greater than the demand of Zones 550 and 660. Consequently, Operational Storage for Zone 550 is not needed. When necessary, Mahr Reservoir can be used to buffer supplies at Meadowlark WRF.

As shown in Table 8.5, there is enough storage to meet operational and short-term emergency demand requirements under existing conditions. In addition, the following conclusions can be made by subarea:

- Since supplies from Meadowlark WRF are taken at a constant rate and are greater than the demand of Zones 550 and 660, operational storage is not considered necessary within Zone 550. When necessary, Mahr Reservoir can be used to buffer supplies at Meadowlark WRF.

- For Zones 384, 580, and 318, which share common reservoir capacity, the total required operational and emergency storage is 2.01 MG. For Zones 550 and 660, the total required operational and emergency storage is 0.77 MG.

8.3 PUMP STATION CAPACITY ANALYSIS

The pump analysis evaluated the adequacy of the existing system pump station capacities. CMWD's existing recycled water system consists of five pressure zones and associated booster pumping stations. The suction and discharge zones and flow capacities for each pump station are listed in Table 8.6. This table lists both the total capacity for each pump station and the firm capacity, which is the capacity with the largest unit out of service. Note that each of CMWD's booster pumping stations include a standby pump and consist of pumping units of uniform sizing, so the design capacity is equivalent to the firm capacity. As discussed in Chapter 7, the criteria for each pump station is to meet the PHD with the largest unit out of service.

Table 8.6 Booster Pump Station Capacity Evaluation
Recycled Water Master Plan
Carlsbad Municipal Water District

Booster Stations	Suction/ Discharge	No. of Pumps	Total Capacity (gpm)	Firm Capacity (gpm)	PHD(3) (gpm)	Balance (gpm)
Bressi PS	550 to 660	2 duty, 1 standby	4,500	3,000	1,015	+1,985
Calavera PS	384 to 580	2 duty, 1 standby	2,700	1,800	724	+1,076
Twin D PS	384 to 550	3 duty, 1 standby	6,000	4,500	1,903	+2,697
Meadowlark WRF PS	WRF to 550	2 duty, 1 standby	-(2)	3,250	2,083	+1,167
Carlsbad WRF PS	WRF to 384	3 duty	10,000	6,667	2,777	+3,890

Notes:
(1) TDH: Total Dynamic Head.
(2) Total capacity from Meadowlark WRF not reported. Single pump can produce 1,389 gpm and two pumps can product 3,250 gpm.
(3) For booster pumping stations, PHD is based on annual downstream demands from Table 2.3, a seasonal peaking factor of 1.7, and a daily peaking factor of 3.0. For treatment facility pump stations, PHD is based on treatment plant capacity from Table 2.1.

As shown in Table 8.6, all pump stations are currently adequately sized and meet the evaluation criteria under existing demand conditions. The Bressi PS and Calavera PS only need to meet existing PHDs of 1,015 and 724 gpm, respectively. They are currently sized for 3,000 and 1,800 gpm. The Twin D Pump Station is capable of transferring all of the flow from the Carlsbad WRF to Zone 550 (approximately 2,700 gpm). Both the Carlsbad WRF PS and the Meadowlark WRF PS are currently sized to deliver peak effluent production from their respective plants.

However, it should be noted that the Calavera and Bressi pump stations function as the sole supply to Zones 580 and 660, respectively. As these pump stations do not have backup power and these zones do not have gravity storage it is recommended that backup power be located at each pump station site.

To continue service in these pressure zones during a power outage, both pump stations need to be equipped with the appropriate switchgear to connect a portable back-up power generator. It is recommended that CMWD have one portable backup power generator to continue service during minor power outages, provided that Bressi PS and Calavera PS are not connected to the same power grid. It is assumed that interruption of recycled water service would be acceptable during a regional power outage or rolling blackout.

8.4 PUMPING EFFICIENCY AND ENERGY ANALYSIS

The energy analysis evaluated each pump station to determine modifications or operational changes that could increase pumping efficiency. The PS examined for possible modifications included:

- Twin D PS
- Bressi PS
- Calavera PS

The Meadowlark WRF PS and Carlsbad WRF PS were not evaluated since their operation is dependent on the upstream operation of the treatment facility. In addition, both of these pump stations have either large upstream equalization basin (at Carlsbad WRF) or a large reservoir (Mahr Reservoir) that allows for optimal pumping of plant effluent.

For the Twin D PS, it is recommended that CMWD operate the pump station at its peak efficiency operating point, which is possible since excess flow may be deposited into the Mahr Reservoir. For each individual unit, the best efficiency point is at 1,500 gpm and 300 feet Total Dynamic Head (TDH). Under normal operations (when Meadowlark WRF is supplying the system), the Twin D PS is not operated on a regular basis. Thus, average annual energy consumption was not calculated.

For the Bressi and Calavera PS, CMWD has recently retrofitted each pump station with a smaller pump capable of more efficiently pumping flow between MinDD and the optimal flow regime of the existing larger pumps. Prior to the retrofit, the Bressi and Calavera PS operated only with upstream hydro-pneumatic tanks. As there is no storage upstream of the Bressi and Calavera PS, the pump station flows must match demand in Zone 580 and Zone 660, respectively. Table 8.7 displays the current demand for each zone and the current efficiency and kilowatts (kWs) required for pumping at the Bressi and Calavera Pump Stations, respectively.

Table 8.7 Power Usage for Hydro-pneumatic Zones
Recycled Water Master Plan
Carlsbad Municipal Water District

Booster Stations	No. of Pumps	Pump Size (gpm)	Zone AAD (gpm)	Efficiency at AAD$^{(1)}$	Estimated Power Usage at ADD$^{(2)}$ (kW)
Bressi PS	2 duty, 1 standby	1,080	199	45%	7.2
Calavera PS	2 duty, 1 standby	620	142	56%	3.5

Notes:
(1) Based on pump curves provided by CMWD and assumes VFD turndown of at least 50 percent is achievable.
(2) Power usage (kW) estimated based on the pump curves provided by CMWD and ADD.

As shown in Table 8.7, there is low efficiency when one of the existing pumps runs to meet the indicated demand. In addition, existing pumps are too large to pump flows much lower than AAD flows without cavitation and backflow that will damage the pumps. A smaller pump at each pump station runs more efficiently than any of the existing pumps when pumping flows below the AAD. The increased efficiency associated with the new smaller pumps both save money and allow the PSs to meet MinDD without damaging the existing pumps. Approximate energy savings are shown in Table 8.8.

Table 8.8 Summary of Facilities by Pressure Zone
Recycled Water Master Plan
Carlsbad Municipal Water District

Booster Stations	New Efficiency	New kW, ADD	Existing kW, ADD	kW Savings	Cost $/kWh	Annual Savings$^{(1)}$
Bressi	80%	4.3	7.2	2.9	$0.13	$5,000
Calavera	80%	2.5	3.5	1.0	$0.13	$1,500

Notes:
(1) Annual savings rounded to nearest $500.

While the annual savings listed in Table 8.8 are not significant, the savings could cover the cost of a small pump, which is needed regardless, since the large pumps are unable to pump MinDD. A smaller pump also reduces wear on the larger pumps due to excessive starting and stopping of the larger pumps.

CMWD has recently retrofitted both the Bressi PS and Calavera PS with smaller pumps capable of both pumping the MinDD and more efficiently pumping flows greater than MinDD, but less than the optimal pumping regime of the existing pumps. This analysis confirms this action.

8.5 WATER QUALITY ANALYSIS

The model was used to analyze recycled water quality based on the chlorine residual in the system. The evaluation was used to determine if CMWD should install additional chlorine injection stations to maintain adequate chlorine residuals throughout its distribution system. For this analysis, it was assumed that the chlorine residual of recycled water leaving the treatment plants would be 9.1 mg/L at Carlsbad WRF and 4.5 mg/L at Meadowlark WRF. The chlorine residual at the Carlsbad WRF is based on the average chlorine residual between September 15 and September 30, 2009. The chlorine residual at the Meadowlark Plant is based on the discussion in Chapter 6. In absence of chlorine jar test data, a global bulk chlorine decay coefficient of -0.05 along with a default global wall chlorine decay coefficient of -0.15 were used. These values are consistent with the values used during the calibration.

Figure 8.3 displays the chlorine residuals in the system as predicted by the hydraulic model. Under AAD conditions, the major transmission mains in the system (not including small laterals) maintain a chlorine residual above 2.0 mg/L. Also, the C Tank, Twin D Tanks, and Mahr Reservoir all have residuals above 2.0 mg/L under AAD conditions. The chlorine residual for all system reservoir and transmission mains is also above 2.0 mg/L under MMD conditions.

However, under MinDD conditions, the model predicts that the chlorine residuals in the C Tank and Mahr Reservoir are 0.02 mg/L and 0.6 mg/L, respectively. The low MinDD creates a low turnover of water in each reservoir, thereby creating a low chlorine residual. For MinDD conditions, many of the transmission mains have a residual below 1 mg/L, especially those mains adjacent to the C Tank. The low residual in the C Tank may be partially due to the limited cycling within the C Tank as its elevation is above the HGL of Zone 384. The higher than expected residual within Mahr Reservoir is likely a limitation of the hydraulic model to adequately predict the increased decay of chlorine residual within a large, open body of water, as the bulk decay rate within Mahr Reservoir is likely higher than that observed in the distribution system pipelines.

CMWD could help alleviate the low chlorine residuals under MinDD conditions by installing a chlorination and mixing system in the low residual reservoirs. CMWD recently completed installation of a chlorination and mixing system for Mahr Reservoir in 2008. It is recommended that CMWD considers installing a mixing and chlorination system at the C Tank to maintain the residual during MinDD periods.

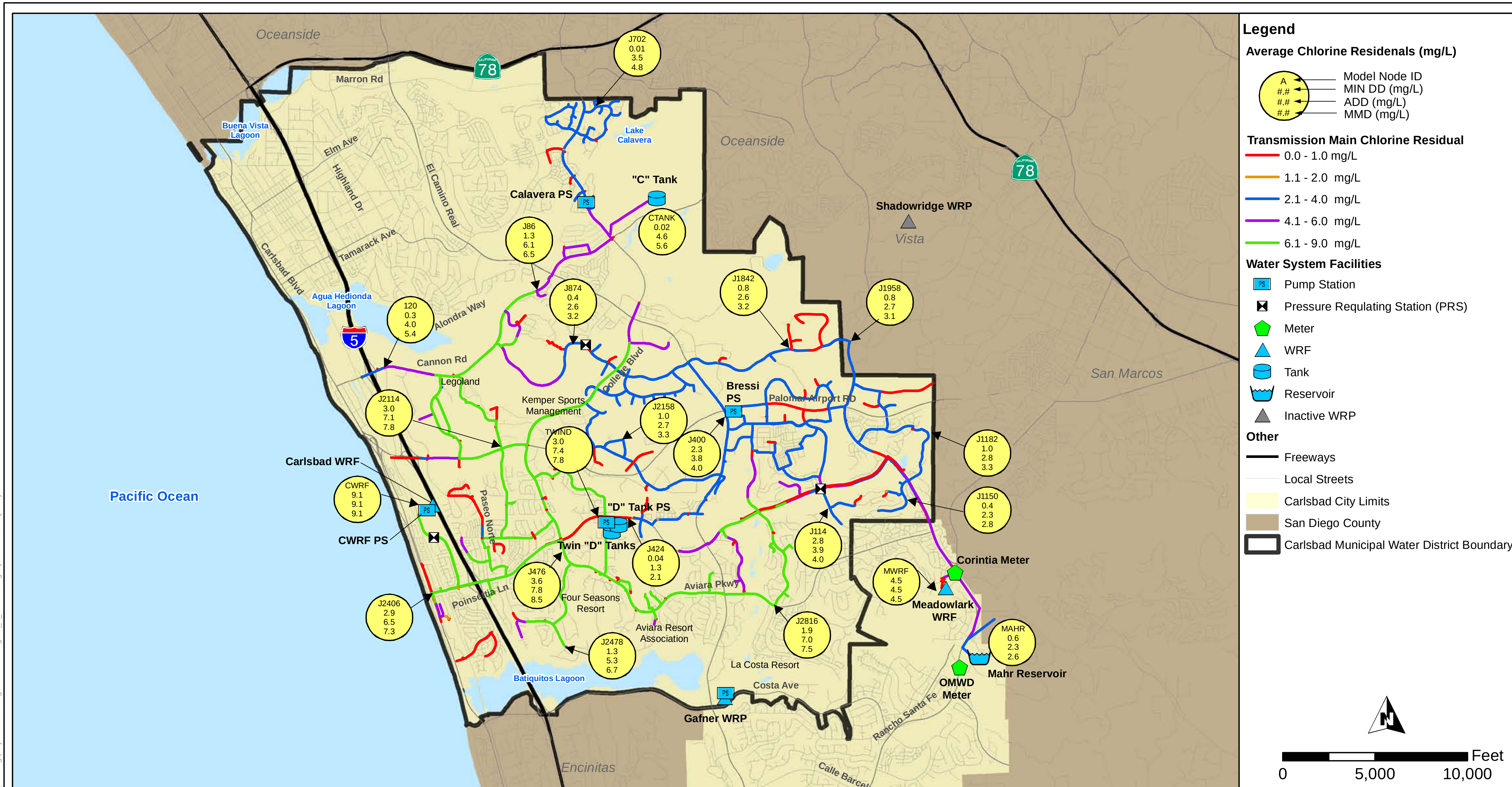

Figure 8.3
Existing Water System Quality
Recycled Water Master Plan
Carlsbad Municipal Water District

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8.6 OPERATIONS AND MAINTENANCE

To keep the existing system operating properly, CMWD may want to start an asset management program for its recycled water system infrastructure. Although these infrastructure assets may function for many years with a relatively small amount of maintenance, these assets will not last forever, and will eventually need to be replaced. The cost of replacing these assets will be very high. CMWD should therefore start with the implementation of an overall asset management program so that the best value possible can be obtained from existing infrastructure and from future infrastructure investments.

As an added benefit of developing an asset management program, CMWD could use such a program to estimate the remaining useful life of pipelines within its distribution system. CMWD could then have a basis for establishing an asset renewal fund.

Part of this program would involve inspecting facilities every year or two to track the condition of system components. Table 8.9 shows typical frequency of inspection and labor hours for its recycled water facilities.

Table 8.9 Facility Inspection Criteria
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility	Frequency of Inspection (years)	Hours Required
Pump Stations	3 - 5	1 - 2
Reservoirs	3 - 5	4
Service Connections	1 - 4	1[(1)]
Large Valve Stations	3 - 5	1 - 2
Pipelines	10 - 12	See Note 2

Notes:
(1) Actual test may take up to 24 hours since data is recorded by a pressure logger. Time only accounts for the test preparation.
(2) For the suggested frequency, CMWD should conduct a mass balance to isolate areas that may have leaks. If a leak is found from the analysis, field verification and inspection may be required.

8.7 SUMMARY OF RECOMMENDATIONS

The existing system was found to have a few hydraulic deficiencies, energy deficiencies, and locations with low chlorine residuals. However, all pump stations are adequately sized and the system has sufficient storage and supplies.

Hydraulic deficiencies involved locations with high pressures, locations with low pressures, pipes with high velocities, and pipes with high head loss. Most of the low pressures were due to higher elevations within the existing zones. Most of the high velocity and high head loss pipes were not adjacent or in the vicinity of low pressure nodes, with the exception of two locations. The limited pressure deficiencies caused by these pipelines are not considered severe enough to warrant replacement at this time. However, CMWD should continue to monitor pressures in the area and, if replacement of these pipeline segments is warranted for other reasons, replace the pipelines with pipelines of a larger capacity.

All other low-pressure areas do not represent significant deficiencies or are due to higher elevations within each zone. It is therefore recommended that CMWD continue present operation without changes, in order to avoid the cost of a new pressure zone and new pump station, unless the number of customers served by a new zone and pump station would justify the cost.

The model predicts low chlorine residuals in the C Tank during MinDD condition. This low residual is consistent with the residual observed during model calibration. To resolve the deficiencies, the following recommendation was made:

- Install a chlorination and mixing system in C Tank to maintain an adequate residual during periods of low demand.

The cost for the chlorination and mixing system is included in the capital improvement program discussed in Chapter 10.

FUTURE SYSTEM EVALUATION

9.1 INTRODUCTION

This chapter describes the evaluation of alternatives for expansion of the existing system to maximize service of the potential customers identified in Chapter 3. The evaluation and sizing criteria described in Chapter 7 are used to size these system expansions. This chapter is divided into the following three sections:

- Evaluation Methodology. This section discusses the methodology used for the creation of expansion segments, as well as the selection of the recommended recycled water system expansion projects.
- Future System Expansion Evaluation. A future recycled water system layout that serves all potential customers was developed and divided into expansion segments. This section presents the pipelines and facilities for each expansion segment, which were sized using the hydraulic model. Planning level cost estimates are also presented for each expansion segment and are prioritized based on unit cost and other considerations.
- Future System Recommendations. The expansion segments are compared and a recommended system is selected for the planning horizon of this recycled water master plan (RWMP). In addition, the ultimate system under build-out conditions is described.

The Capital Improvement Program (CIP) for the recommended ultimate build-out system is described in Chapter 10 of this RWMP.

9.2 EVALUATION METHODOLOGY

For the future system evaluation, the hydraulic model was used to develop potential system expansion alternatives that can serve the projected demands while meeting the supply and evaluation criteria constraints. This section discusses the methodology used for the creation of alternatives and the selection of recommended recycled water system expansion projects. This methodology includes the following steps:

- Development of the initial system layout
- Division of the initial layout into expansion segments
- Evaluation of redundancy alignments and inclusion of abandoned assets
- Selection of recommended system

The first step in developing a future system is the development of the initial layout of a potential recycled water system. This system would serve the potential customer demands with the potential recycled water supplies as discussed in Chapters 3 and 4, respectively.

Pipeline alignments were laid out in an attempt to provide service to all potential customers. The pipeline alignments were divided into expansion segments. These expansion segments were refined with input from CMWD staff, who also identified additional pick-up customers where feasible, along the proposed pipeline alignments.

Implementation of all expansion segments would maximize the use of recycled water; however, the total cost of a system serving all potential customers is typically relatively high. To make expansion of the recycled water system more cost-effective, the various segments are evaluated based on relative cost expressed in dollars per acre-foot of demand served. The segments are then prioritized based on this unit cost evaluation and incorporated into a phased CIP.

9.3 FUTURE SYSTEM EXPANSION EVALUATION

The market assessment conducted in Chapter 3 identified 161 largest customers totaling 5,368 afy (4.8 mgd) as the total potential future system demand in the customer database. This new demand includes 2,711 afy (2.4 mgd) within CMWD's service area and 2,657 afy (2.4 mgd) in the service areas of neighboring agencies. Expansion segments were developed to maximize the number of customers that could be connected to the recycled water distribution system. However, several customers were determined to be too distant from the recycled water distribution system or isolated such that connection to recycled water would not be viable.

To evaluate the cost effectiveness and priority of the various expansion segments, the segments were assigned based on contiguous or nearby potential customers. The potential segments are shown on Figure 9.1. A summary of the potential customer demands by segment is provided in Table 9.1. Some potential customers were not able to be reached by the proposed segments; these are summarized separately in Table 9.1 as "Excluded". In addition, some potential customers are located adjacent to the existing recycled water distribution system and do not require a new pipeline. These are labeled "Adjacent to Existing".

9.3.1 Expansion Segments

As shown in Table 9.1, the potential demand that can be served if all expansion segments are implemented is estimated to be 4,662 afy (4.2 mgd). This is calculated by deducting 706 afy of demand that was excluded from the customer database demand of 5,368 afy.

The potential demand of 4,662 afy (4.2 mgd) includes 3,695 afy (3.3 mgd) of demand associated with conversions of existing potable water customers and 967 afy (0.9 mgd) of demand associated with new customers (not offsetting existing potable water demands). While some new demands may not be in place when Phase III is implemented, it is assumed that all demands will be connected at ultimate build out. For developing unit costs for each alignment, the ultimate average annual demands were used.

Table 9.1 Demands by Expansion Segment
Recycled Water Master Plan
Carlsbad Municipal Water District

Expansion Segment	Number of Customers(4)	Average Annual Demand (afy) Potable Water Customers	New Demands in Customer Database(5)	Ultimate System(6)
Adjacent to Existing(1)	30	126	472	598
1	19	97	8	105
2	13	782	0	782
3	6	53	280	333
4A(2)	1	448	0	448
4B(2)	9	330	0	330
4C(2)	1	582	0	582
5	16	193	129	322
6	3	20	0	20
7	1	0	64	64
8	2	520	0	520
9	5	65	13	78
10	2	82	0	82
11	16	120	0	120
12	4	41	0	41
13	2	32	0	32
14	2	58	0	58
15	3	22	0	22
16	1	10	0	10
17	6	85	0	85
18	1	31	0	31
Total	**143**	**3,695**	**967**	**4,662**
Excluded(3)	18	706	0	706
Grand Total	**161**	**4,401**	**967**	**5,368**

Notes:
(1) This category consists of potential customers adjacent to the existing recycled water distribution system that do not require a specific expansion segment and that can directly connect to the system through a customer lateral. This category is assumed to include 30 service laterals.
(2) Three segments are included in Segment 4. Each will be discussed in more detail in Section 9.3.1.
(3) These demands excluded as the associated potential customers were not able to be efficiently connected to the ultimate recycled water distribution system.
(4) The specific expansion segment to which each customer is assigned can be found in Appendix C. Note that the number of customers does not necessarily correspond to the number of service laterals required for retrofit customers. See individual expansion segment descriptions.
(5) New Demands are not anticipated to be ready to connect by the time Phase III is completed.
(6) Total of Potable Water Customers and New Demands.

Each of the segments is described briefly below. As shown as the sum of demands in the category “Adjacent to Existing”, the customer database identified 598 afy of potential demand located adjacent to the existing recycled water distribution system, which does not require an expansion of the system. In addition, potential customers representing 706 afy of potential demand (shown as “Excluded” in Table 9.1) were not considered viable for connection to the recycled water distribution system in any of the expansion alternatives due to the remote location of the customers.

9.3.1.1 Expansion Segment 1

Expansion Segment 1 consists of 15,400 feet of pipeline to serve 19 identified customers with an ultimate system demand of 105 afy. This segment would be a part of Zone 550. Expansion Segment 1 is located in the center of CMWD’s service area and consists of connecting customers in the business park surrounding Palomar Airport Road. While Phase II identified several of these customers, some of the expansions were not able to be completed under Phase II. CMWD staff suggested the alignments shown in Expansion Segment 1. CMWD staff estimated that 58 service laterals will be required to connect existing potable customers in this expansion segment. Costs for the laterals have been included in the overall cost for this segment.

It should be noted that a number of cooling tower demands totaling an estimated 44 afy have been aggregated into Expansion Segment 1. Due to proximity, many of these demands are for customers that are already on recycled water for irrigation and could be served without any new pipelines. As discussed in Chapter 3, these demands were estimated in aggregate and would require an individual connection to each commercial building as appropriate.

9.3.1.2 Expansion Segment 2

Expansion Segment 2 consists of 17,500 feet of pipeline to serve 13 customers with an ultimate system demand of 782 afy. This segment would be a part of Zone 384 and extend the recycled water system north from Carlsbad WRF along Avenida Encinas to the new power plant and across the lagoon. It is estimated that 18 service laterals will be required to serve existing potable customers in this expansion segment.

Although previous recycled water studies have placed this expansion segment in a lower pressure zone, it was decided to raise the hydraulic grade line (HGL) in order to increase looping in Zone 384 and eliminate a pressure reducing station and booster pumping station. Preliminary analysis showed maximum pressure along this alignment as 196 psi at an elevation of 29 ft-msl. Increasing the HGL to Zone 384 will also allow uniform head conditions for all booster pumps at the Carlsbad WRF Pump Station. In addition, this will increase redundancy in the distribution system, as supplies from Carlsbad WRF will be conveyed via transmission mains along Palomar Airport Road and Cannon Road in addition to the transmission main along Poinsettia Lane.

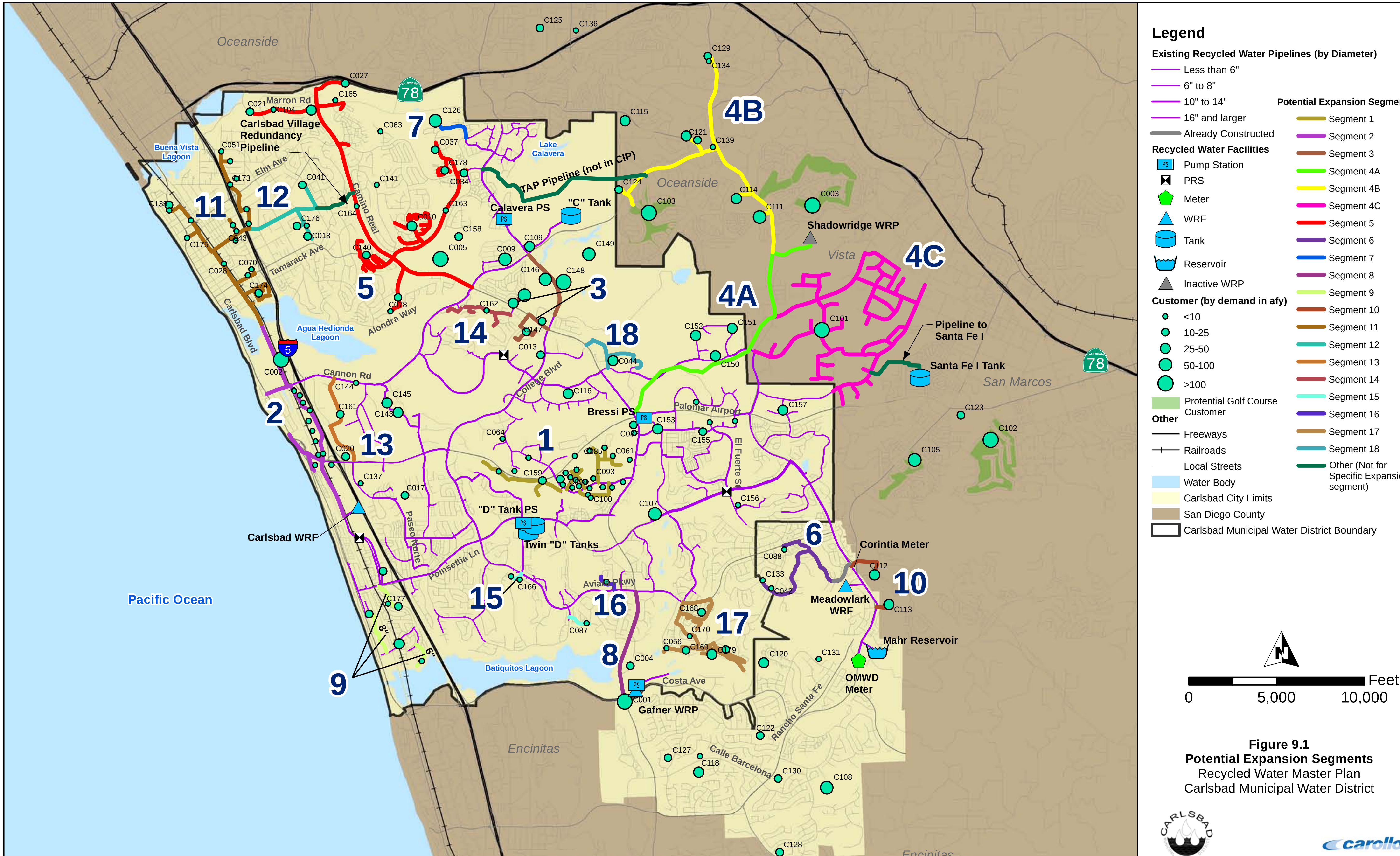

Figure 9.1
Potential Expansion Segments
Recycled Water Master Plan
Carlsbad Municipal Water District

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9.3.1.3 Expansion Segment 3

Expansion Segment 3 consists of 8,600 feet of pipeline to serve 6 customers with an ultimate system demand of 333 afy. Expansion Segment 3 connects several potential developments and existing Home Owner's Association (HOA) customers along College Blvd and El Camino Real, looping sections of Zone 384 and providing redundancy to the Calavera Pump Station and Zone 384. This alignment includes 280 afy of demand associated with new customers in addition to 53 afy of demand from retrofitting existing potable water customers. Most of this segment would be a part of Zone 384. However, the proposed Holly Springs HOA would require a higher HGL due to its higher elevation.

As shown, the alignment includes pipelines to the proposed Holly Springs HOA, extending outside the public right-of-way. However, as development plans become more certain, the alignment can be planned to follow public streets once they have been determined. Service to the Holly Springs HOA will require a booster pumping station due to the elevation difference of about 180 feet. It is anticipated that the developer will provide a small booster pumping station for serving irrigations demands where the pressures fall too low. The associated booster pumping station and distribution pipelines for the Holly Springs HOA, as well as service laterals for all new customers, are assumed to be the responsibility of the developer and are not included in the CIP.

Note that the Rancho Carlsbad Executive Golf Course is located near the alignment of this expansion segment, but based on discussions with CMWD staff, it is anticipated that the golf course will be served from Jackspar Drive, making it a part of Expansion Segment 14.

9.3.1.4 Expansion Segment 4 (VID and Oceanside)

Expansion Segment 4 is intended to evaluate the potential of serving demands within Vista Irrigation District (VID) and the southeast portion of the City of Oceanside. Three expansion segments were developed for Expansion Segment 4. These are:

- Expansion Segment 4A – Wholesale Service to VID at Shadowridge Water Reclamation Plant (WRP)
- Expansion Segment 4B – Retail Service to VID and southeast Oceanside customers north of Shadowridge WRP
- Expansion Segment 4C – Retail Service to all identified customers within VID south of Shadowridge WRP

The alignments of each expansion segment are presented on Figure 9.2, Figure 9.3, and Figure 9.4, while the demand and pipeline lengths are summarized in Table 9.2. As shown in this table, the ultimate system demand of the three expansion segments totals 1,360 afy.

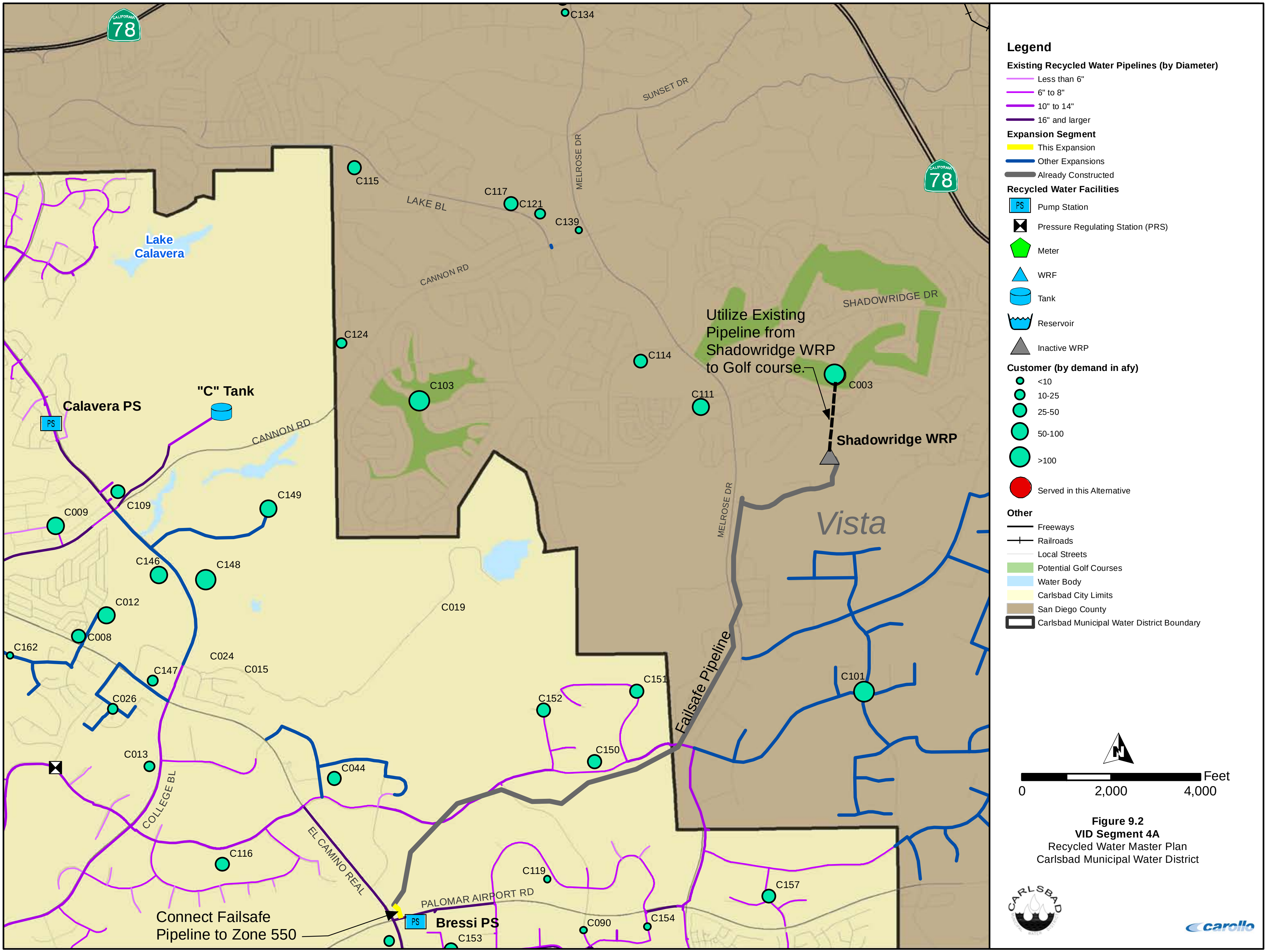

Figure 9.2
VID Segment 4A
Recycled Water Master Plan
Carlsbad Municipal Water District

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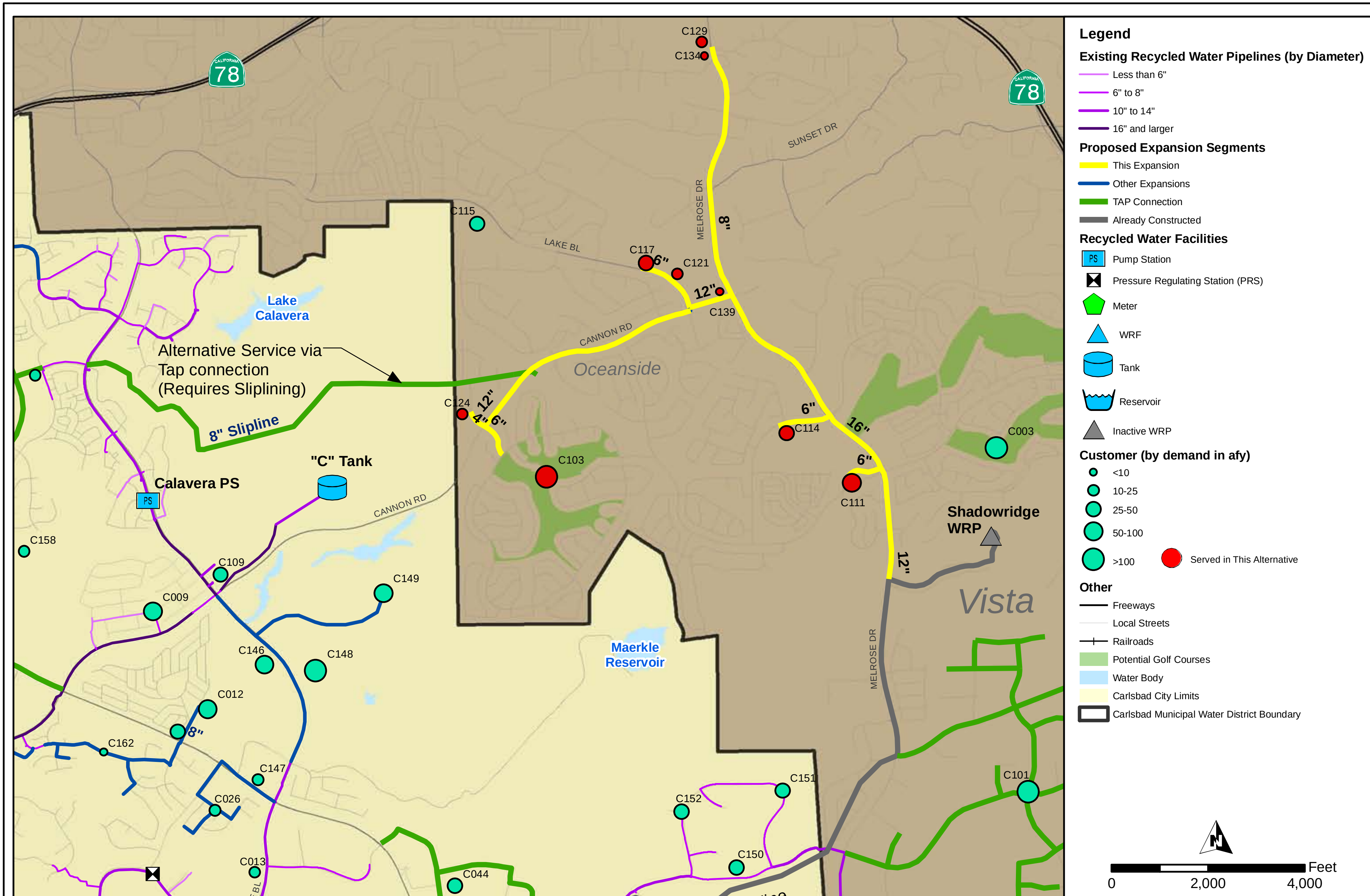

Figure 9.3
VID Segment 4B
Recycled Water Master Plan
Carlsbad Municipal Water District

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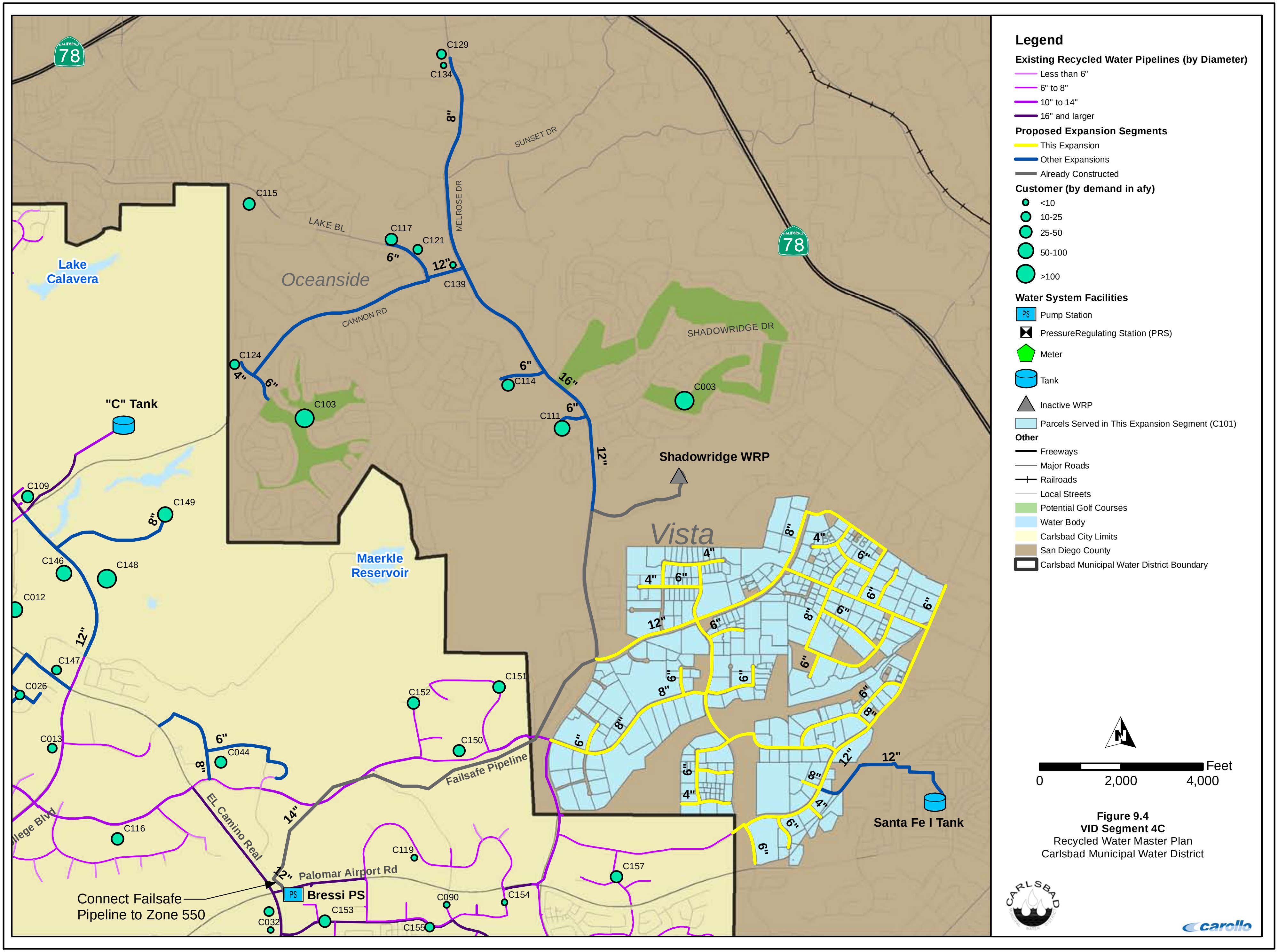

Figure 9.4
VID Segment 4C
Recycled Water Master Plan
Carlsbad Municipal Water District

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Table 9.2	**Expansion Segments for Serving Demands in VID (Segment 4)** Recycled Water Master Plan Carlsbad Municipal Water District				
Segment	**Number of Customers(3)**	**Pipeline Length (ft)**	**Booster Required**	**Ultimate System Demand (afy)**	**Notes**
4A	1	700	No	448	Uses Shadowridge WRP for storage
4B	9	23,200	No	330	Includes demand from Segment 4A
4C	369(1)	63,800	Yes(2)	582	Includes demand from Segment 4A and 4B
Total	**379**	**87,700**		**1,360**	

Notes:
(1) While listed as one entry in the customer database, the large business park southeast of Shadowridge WRP served by Expansion Segment 4C actually represents a large number of potential landscape irrigation demands. Considered individually, these demands are quite small. However, CMWD has converted a large number of similar landscape irrigation demands in its own business parks.
(2) A booster station would be required to serve customers connected to segment 4C from the failsafe pipeline. However, Bressi PS could be used to serve these customers directly from CMWD's existing Zone 660.
(3) Specific customers served by each segment are shown on Figure 9.2, Figure 9.3, and Figure 9.4. Number of customers for Segment 4C is approximated based on the number of parcels.

A list of customers included in each alternative is shown in Table 9.3. Preliminary hydraulic analysis using the hydraulic model shows that the HGL of Zone 550 will convey sufficient pressure to directly drive flow through the failsafe pipeline. It is assumed that sufficient operational storage is available at Shadowridge WRP to buffer the difference between supply via the failsafe pipeline and recycled water demands over the course of the day. However, with a ground elevation approximately 440 ft-msl at the Shadowridge WRF, if existing storage capacity at Shadowridge WRP is used, a pump station would be required to serve potential customers at an HGL of 550 ft-msl.

Expansion Segment 4A, depicted in Figure 9.2, consists of providing recycled water to Shadowridge WRP through the existing failsafe pipeline to supply only the demands associated with the Shadowridge Golf Course.

Expansion Segment 4B, depicted in Figure 9.3, consists of supplying all identified VID and City of Oceanside (COO) customers that could be supplied at a HGL of 550 ft-msl. Again, recycled water is provided to Shadowridge WRP through the existing failsafe pipeline. Recycled water is then supplied to customers through a distribution system from Shadowridge WRP.

Expansion Segment 4C would serve irrigation demands in the large business park to the southeast of Shadowridge WRP. The increased elevation of the business park will require an HGL of about 660 ft-msl. Based on a PHD of 1,840 gpm and a pumping head of

133 feet, this could be accomplished through a booster pumping station sized at about 90 hp, or by using the existing capacity of the Bressi PS.

Table 9.3 Customer Demands in Expansion Segment 4 Alternatives
Recycled Water Master Plan
Carlsbad Municipal Water District

Customer ID	Customer Name	Existing Purveyor	Ultimate System Demand (afy)	Expansion Segment
C003	Shadowridge Golf Course	VID	448	4A
C103	Ocean Hills Country Club	COO	148	4B
C111	Buena Vista Park	VID	54	4B
C114	Rancho Buena Vista High	VID	39	4B
C117	Madison Middle/Lake Elementary	COO	34	4B
C121	Lake Park	COO	22	4B
C124	New Venture Christian Schools	COO	13	4B
C129	Breeze Hill Park	VID	11	4B
C134	Breeze Hill Elementary	VID	8	4B
C139	Montessori of Oceanside	COO	1	4B
C101	Business Park	VID	582	4C

It should be noted that demands for the business park (Customer ID C101) were estimated based on typical water demand factors calculated from existing recycled water demands for business parks in CMWD's service area. The business park was not included in VID's identified potential customers. Since providing recycled water to the business park would include a number of retrofit connections, costs for service laterals were included based on the number of parcels in the business park. A total of 369 service laterals are included in the cost for this expansion segment.

9.3.1.5 Expansion Segment 5

Expansion Segment 5 consists of 54,200 feet of pipeline to serve 16 customers with an ultimate system demand of 322 afy. This segment would be a part of Zone 384, extending the recycled water distribution system north along El Camino Real to serve the second phase of Robertson's Ranch, several existing HOAs, and existing landscape irrigation.

9.3.1.6 Expansion Segment 6

Expansion Segment 6 consists of 3,900 feet of pipeline to serve 3 customers with an ultimate system demand of 20 afy. The La Costa Ridge HOA is currently served recycled water by a private pump station and existing pipeline near Meadowlark WRF. It is anticipated that CMWD will take over operation of the pump station and pipeline. Expansion Segment 6 would build upon this existing pipeline, extending it to serve 3 additional customers near the La Costa Ridge HOA. Costs are not anticipated or included for incorporating the existing private pump station and pipeline into CMWD's system; rather the costs for Expansion Segment 6 consist solely of new pipeline to reach the 3 additional customers. Note that the capacity of the existing pump station was not evaluated; it was assumed that the pump station would have sufficient spare capacity to accommodate the additional demands.

9.3.1.7 Expansion Segment 7

Expansion Segment 7 consists of 2,500 feet of pipeline to serve 1 customer with an ultimate system demand of 64 afy. Expansion Segment 7 provides service to the Quarry Creek development from Zone 580. Based on an estimated elevation of 117 ft-msl, static pressures could exceed 200 psi. Thus, a pressure regulator may be required. However, it is anticipated that this would be constructed on site and paid for by the developer. Based on input from CMWD staff, it is anticipated that the alignment along Tamarack Avenue and down the hillside, crossing approximately 300 feet of HOA property outside the public right of way, is preferable to the alignment along Milford Place or College Boulevard and Marron Road, portions of which would extend outside CMWD's service area.

9.3.1.8 Expansion Segment 8 (OMWD and La Costa Resort and Spa)

Expansion Segment 8 consists of 6,500 feet of pipeline to serve La Costa Resort and Spa and OMWD's demands lower zone demand with an ultimate system demand of 520 afy. This segment would be a part of Zone 384. Expansion Segment 8 consists of a pipeline along El Camino Real, connecting CMWD's recycled water system to OMWD and existing landscape irrigation at La Costa Resort and Spa. The feasibility of developing this alternative depends greatly on the timing of recycled water needs from OMWD.

Alternatively, this alignment could also be used to connect LWWD's (Leucadia Wastewater District) currently isolated Gafner WRP distribution system to CMWD's extensive recycled water distribution system, assuming appropriately sized pumps would be installed at Gafner WRP to deliver flows to Zone 384. Based on alternative 4 supply recommendation in Chapter 4, Gafner would not be utilized as a supply source. If another supply alternative from Chapter 4 is used, use of Gafner may be beneficial to CMWD.

9.3.1.9 Expansion Segment 9

Expansion Segment 9 consists of 5,800 feet of pipeline to serve 5 customers with an ultimate system demand of 78 afy. This segment would be a part of Zone 318, expanding the recycled water system south to the San Pacifico HOA and various existing landscape irrigation and potential development. A portion of this alignment extends Zone 318 south along Avenida Encinas to the Poinsettia Village shopping center and the Lake Shore Garden mobile home park.

9.3.1.10 Expansion Segment 10 (VWD)

Expansion Segment 10 consists of 3,400 feet of pipeline to serve 2 customers with an ultimate system demand of 82 afy. This segment would be a part of Zone 550 and would serve the commercial development in Vallecitos Water District's (VWD) service area near Meadowlark WRF. It is anticipated that the south leg of this alignment could be connected directly to VWD's pipeline (upstream from CMWD's meter).

9.3.1.11 Expansion Segment 11

Expansion Segment 11 consists of 25,700 feet of pipeline to serve 16 customers with an ultimate system demand of 120 afy. This segment would be a part of Zone 384, extending Expansion Segment 2 north to the Carlsbad Village, serving existing parks, schools, and landscape irrigation demands in the Carlsbad Village area. The proposed alignment crosses Interstate 5 at Chestnut Avenue, extending north along the freeway to Holiday Park, the civic center, and Buena Vista school.

This expansion segment will require either Expansion Segment 2 or Expansion Segments 5 and 12 (with the loop connection along Chestnut Avenue).

9.3.1.12 Expansion Segment 12

Expansion Segment 12 consists of 8,100 feet of pipeline to serve 4 customers (representing 14 meters) with an ultimate system demand of 41 afy. This segment would be a part of Zone 384. Expansion Segment 12 extends Expansion Segment 11 north from Carlsbad Village to several schools.

Pressures for customers at the highest elevation portions of this expansion segment are predicted by the hydraulic model to be at a minimum of 85 psi.

This alignment is dependent on Expansion Segment 2 and Expansion Segment 11 or Expansion Segment 5 with the loop connection along Chestnut Avenue.

9.3.1.13 Expansion Segment 13

Expansion Segment 13 consists of 5,900 feet of pipeline to serve 2 customers with an ultimate system demand of 32 afy. This segment would be a part of Zone 384, serving customers along Paseo Del Norte and Car Country Drive, connecting the Zone 384 pipelines along Cannon Road and Palomar Airport Road.

9.3.1.14 Expansion Segment 14

Expansion Segment 14 consists of 5,900 feet of pipeline to serve 2 customers with an ultimate system demand of 58 afy. This segment would be a part of Zone 384 and would connect the Carlsbad Canterbury HOA and Rancho Carlsbad Executive Golf Course to the existing recycled water distribution system, connecting some existing recycled water pipeline segments currently conveying potable water along Jackspar Drive and Frost

Avenue. After development of Expansion Segment 3, this Expansion Segment will connect the Zone 384 pipeline in Cannon Road with the Zone 384 pipeline in College Boulevard. Note that the Rancho Carlsbad Golf Course could be served from Expansion Segment 3; but based on discussions with CMWD staff, it is anticipated that the golf course will be connected from Jackspar Drive rather than along El Camino Real.

9.3.1.15 <u>Expansion Segment 15</u>

Expansion Segment 15 consists of 2,300 feet of pipeline to serve a total of 9 meters for 4 HOAs (listed as 3 customers in the customer database) with an ultimate system demand of 22 afy. This segment would be a part of Zone 384, connecting the Viaggio HOA, Aviara Masters HOA, and Marea to the existing recycled water distribution system. A second leg of this alignment connects the Tramonto HOA to the existing recycled water distribution system and can connect to a potential HOA development south of Hummingbird Road.

9.3.1.16 <u>Expansion Segment 16</u>

Expansion Segment 16 consists of 1,400 feet of pipeline to serve 3 meters for the Pavoreal HOA with an ultimate system demand of 10 afy. This segment would be a part of Zone 384, connecting the Pavoreal HOA to the existing recycled water distribution system.

9.3.1.17 <u>Expansion Segment 17</u>

Expansion Segment 17 consists of 19,000 feet of pipeline to serve 6 customers with an ultimate system demand of 85 afy. This segment would be a part of Zone 384, connecting the HOAs north of La Costa Resort to the existing recycled water system. This alignment connects the Greenview HOA, Alga Hills HOA, Jockey Club HOA, Alicante Hills HOA, and the Fairways HOA to the existing recycled water distribution system.

9.3.1.18 <u>Expansion Segment 18</u>

Expansion Segment 18 consists of 5,400 feet of pipeline to serve 17 existing meters (listed in the customer database as an aggregate of several customers in an area) with an ultimate system demand of 31 afy. This segment would be a part of Zone 550, connecting several existing commercial irrigation demands north of Faraday Avenue to the existing recycled water distribution system.

9.3.2 Other System Expansion Pipelines

In addition to the 18 expansion segments developed to connect potential customers, three expansion segments were developed for other reasons, including looping, connection to storage, and increasing redundancy in the system. While cost evaluations for each of these segments will be presented later in this chapter, a short description of each expansion segment is provided here. Note that since the purpose of these segments is not to connect potential customers, they will not be included in the expansion segment unit cost development in Section 9.3.3, but cost estimates for each will be discussed later in this chapter.

9.3.2.1 Redundancy Pipeline for Carlsbad Village

This pipeline would connect Expansion Segment 12 and Expansion Segment 5 to provide a second supply of recycled water to the Carlsbad Village. This pipeline would consist of 4,200 feet of pipeline. Since Expansion Segments 5 and 12 are both a part of Zone 384, no pressure regulating or booster pumping stations are anticipated to be required. This pipeline would also serve as an alternate way to connect Expansion Segment 12 if Expansion Segment 11 or 2 are not constructed.

9.3.2.2 TAP Pipeline

The Tri-Agency Pipeline (TAP) pipeline consists of a 20-inch diameter pipeline just under 2 miles in length from College Boulevard to Cannon Road across the undeveloped area south of Lake Calavera. The pipeline was a part of the potable water system and is no longer necessary. This pipeline could be used as an alternative to repurposing the failsafe pipeline in Expansion Segment 4 and could serve City of Oceanside demands in Expansion Segment 4B without using the failsafe pipeline. An evaluation of the costs for sliplining the TAP pipeline as an alternative to using the failsafe pipeline is included in Section 9.3.9.2.

9.3.2.3 Pipeline to Santa Fe I

The Santa Fe I tank is a 2.5 MG abandoned potable reservoir at an elevation suitable as gravity storage for Zone 660. While the tank is connected to an abandoned pipeline along Palomar Airport Road, portions of the pipeline have been destroyed. An alternate alignment over a shorter distance of 4,200 feet from the north would connect the tank to pipelines proposed as a part of Expansion Segment 4C. The rehabilitated Santa Fe I tank could then provide gravity storage for CMWD’s existing Zone 660 as well as customers connected by Expansion Segment 4C. Further discussion of this pipeline is included in the storage analysis in Section 9.3.11.

9.3.2.4 Pipelines to Potential Developments

In addition to the potential customers identified in the customer database that would be served with the expansion segments discussed above, there were additional demands identified in Chapter 3 that are associated with new developments. Pipelines extending to these developments are included as a separate category due to the indefinite timing of these developments.

The demands and pipelines associated with serving these developments were included in the hydraulic model in order to adequately size the system for build-out demand conditions. However, unit costs were not developed for it. Development pipelines are shown on the build-out map for reference, though it is anticipated that more detailed routing and sizing of these pipelines should be developed as more details on the developments are made available.

9.3.3 Alternatives Sizing and Cost Estimates

A pipeline diameter of 8 inches was initially used for all looped pipeline segments. Smaller diameter pipelines were used for dead end pipelines as discussed in the evaluation criteria established in Chapter 7. Where found to be deficient using the hydraulic model, pipeline diameters were increased based on the velocity and head loss criteria specified in Chapter 7. Where pressures fell below the evaluation criteria of 60 psi, booster stations were added to specific expansion segments (as noted previously in Section 9.3.1).

The length of pipeline for each alternative and associated preliminary cost estimate is summarized in Table 9.4. The alignment demands and unit costs presented in Table 9.4 are shown graphically in Figure 9.5 along with the cumulative demand contributed by each expansion segment. Detailed information on the unit cost development and cost estimate assumptions are included in Chapter 10. Preliminary conveyance cost estimates are shown here to aid in prioritization of potential expansion segments.

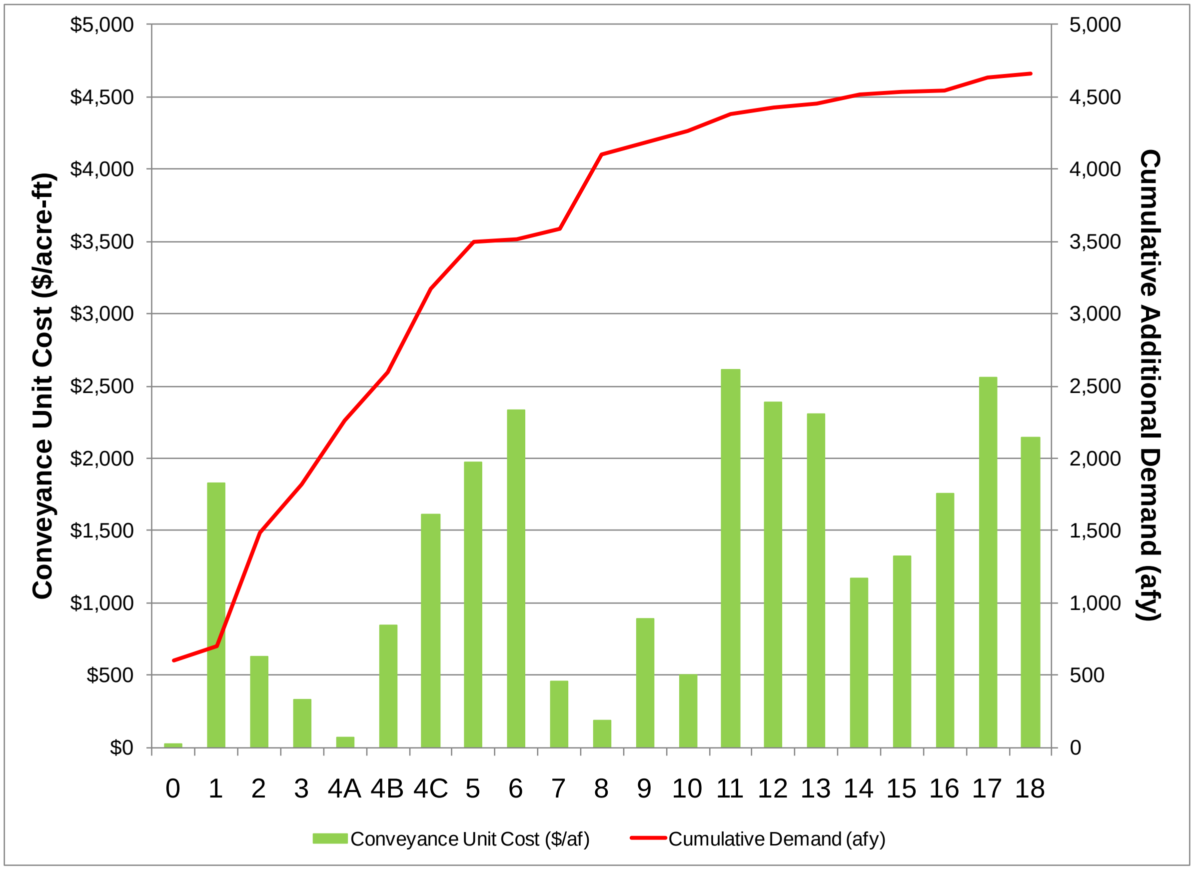

Figure 9.5 Expansion Segment Unit Costs

As shown in Figure 9.5, the estimated conveyance unit costs range significantly from less than $100/acre-foot to over $2,500/acre-foot. Note that the other system expansion pipelines discussed in Section 9.3.2 are not included since their primary purpose is not to connect potential customers.

Table 9.4 Expansion Segments Preliminary Cost Estimates
Recycled Water Master Plan
Carlsbad Municipal Water District

Expansion Segment	Potential Demand (afy)	Pipeline Length (ft)	Capital Cost(2)	Annual Cost(3)	Unit Conveyance Cost ($/af)
0	598	-	$185,000	$12,000	$20
1	105	15,400	$3,025,000	$192,000	$1,833
2	782	17,500	$7,700,000	$489,000	$626
3	333	8,600	$1,755,000	$111,500	$335
4A	448	700	$485,000	$31,000	$69
4B	330	23,200	$5,220,000	$331,500	$1,005
4C	582	63,800	$14,820,000	$940,500	$1,615
5	322	54,200	$9,995,000	$634,500	$1,969
6	20	3,900	$725,000	$46,000	$2,330
7	64	2,500	$540,000	$34,500	$535
8	520	6,500	$1,505,000	$95,500	$184
9	78	5,800	$1,090,000	$69,500	$894
10	82	3,400	$650,000	$41,500	$504
11	120	25,700	$4,955,000	$314,500	$2,614
12	41	8,100	$1,545,000	$98,500	$2,391
13	32	5,900	$1,145,000	$73,000	$2,303
14	58	5,900	$1,070,000	$68,000	$1,166
15	22	2,300	$445,000	$28,500	$1,319
16	10	1,400	$265,000	$17,000	$1,753
17	85	19,000	$3,410,000	$216,500	$2,558
18	31	5,400	$1,125,000	$71,500	$2,306
Total(4)	**4,662**	**279,200**	**$61,495,000**	**$3,906,500**	**n/a**

Notes:
(1) Includes costs for pipelines as well as pressure regulating stations and booster pumping stations as required. These additional facilities are discussed in Section 9.3.1.
(2) Capital Cost includes a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent. Cost estimates and cost assumptions are discussed in detail in Chapter 9.
(3) Annual cost assumes a useful life of 50 years and 6.0 percent interest.
(4) Excludes Expansion Segment 19 and thus differs from Table 9.1 total by 4 afy.

9.3.4 Alternatives Ranking and Prioritization

The expansion segments presented in Section 9.3.1 were prioritized based on unit conveyance cost estimates presented in Table 9.4. The resulting ranking is presented in Table 9.5 and graphically shown in Figure 9.6. This figure also shows the cumulative demand added to the existing system if all expansion segments were constructed in the order of increasing unit cost. The total cumulative demand listed in Table 9.5 includes CMWD's existing and near-term demands as well as all potential demands discussed in Chapter 3.

Table 9.5 Expansion Segments Ranking
Recycled Water Master Plan
Carlsbad Municipal Water District

Rank	Expansion Segment	Pipeline Length (ft)	Capital Cost(1)	Alignment Unit Cost ($/af)	Cumulative Potential Demand (afy)	Total Cumulative Demand (afy)(2)
0	0	-	$185,000	$20	598	4,215
1	4A	700	$485,000	$69	1,046	4,663
2	8	6,500	$1,505,000	$184	1,566	5,183
3	3	8,600	$1,755,000	$335	1,898	5,515
4	7	2,500	$460,000	$458	1,963	5,580
5	10	3,400	$650,000	$504	2,045	5,662
6	2	17,500	$7,700,000	$626	2,827	6,444
7	9	5,800	$1,090,000	$894	2,904	6,521
8	4B	23,200	$5,220,000	$1,005	3,234	6,851
9	14	5,900	$1,070,000	$1,166	3,293	6,910
10	15	2,300	$445,000	$1,319	3,314	6,931
11	4C	63,800	$14,820,000	$1,615	3,896	7,513
12	16	1,400	$265,000	$1,753	3,906	7,523
13	1	15,400	$3,025,000	$1,833	4,011	7,628
14	5	54,200	$9,995,000	$1,969	4,333	7,950
15	18	5,400	$1,045,000	$2,145	4,364	7,981
16	13	5,900	$1,145,000	$2,303	4,396	8,013
17	6	3,900	$725,000	$2,330	4,416	8,033
18	12(3)	8,100	$1,545,000	$2,391	4,457	8,074
19	17	19,000	$3,410,000	$2,558	4,541	8,158
20	11(3)	25,700	$4,955,000	$2,614	4,662	8,279
Total(4)		**279,200**	**$61,495,000**		**4,662**	**8,279**

Notes:
(1) Cost estimates and cost assumptions are discussed in detail in Chapter 9.
(2) Includes existing plus near-term demand of 3,617 afy (based on reduced 2010 demands).
(3) Expansion Segment 12 requires implementation of Expansion Segment 11, which requires Expansion Segment 2.
(4) Excludes Expansion Segment 19 and thus differs from Table 9.1 total by 4 afy.

As shown in Table 9.5, if all expansion segments are implemented, approximately 4,662 afy of demand would be added to CMWD's system at a total capital cost of about $61 million for distribution system components. This equates to an average unit capital distribution system cost of $837 per acre-foot.

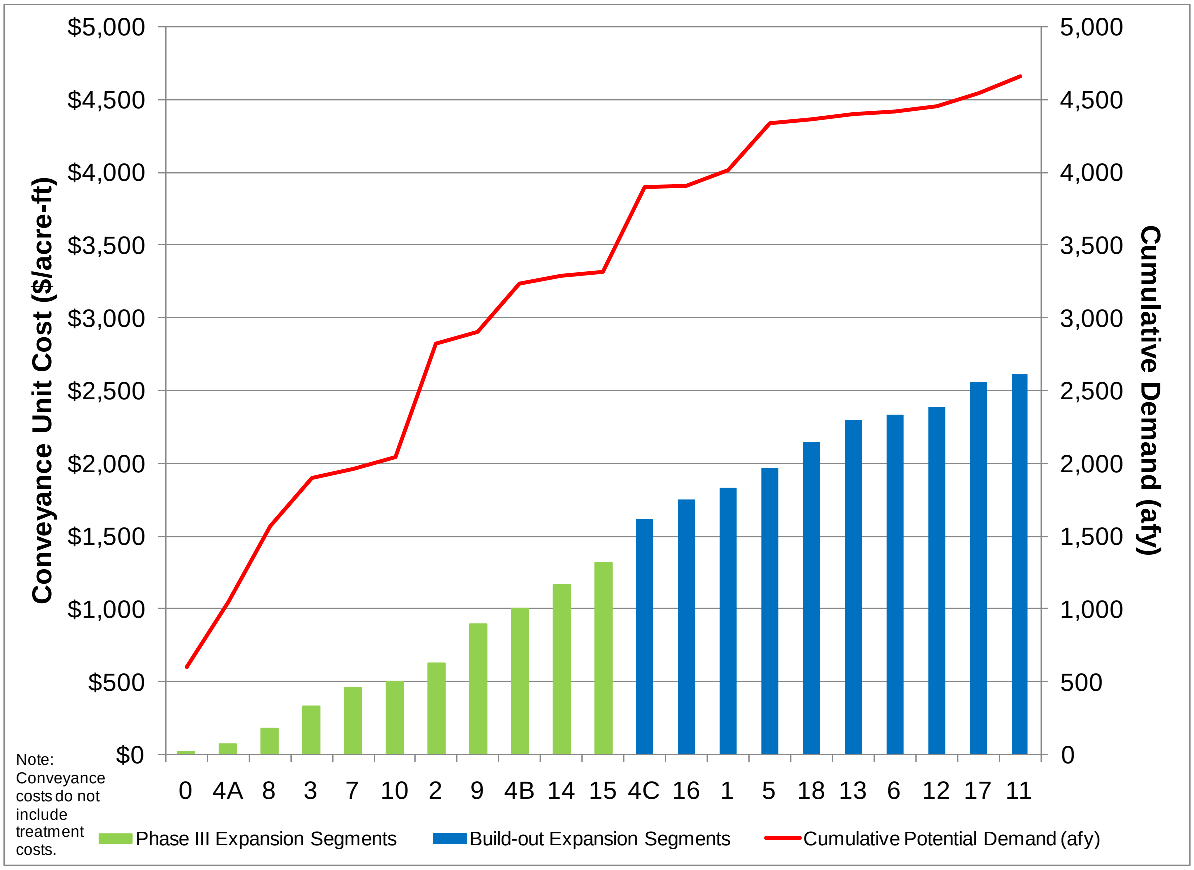

Figure 9.6 Expansion Segment Unit Costs

As shown in Figure 9.6 the incremental new demand decreases after implementation of Expansion Segment 4C, while the unit cost for conveyance continues to increase. Since implementation of Expansion Segment 4C will require significant inter-agency coordination and because this segment marks the point where the unit conveyance cost exceeds $1,500/acre-foot, it was decided to define all segments up through Expansion Segment 15 as Phase III and categorize the remaining segments for the Build Out.

Details regarding Phase III and the Build Out Phase are discussed in more detail below.

9.3.5 Preferred Alternative - Phase III

As shown in Table 9.5 and Figure 9.6, the unit conveyance costs (not including treatment costs) for expansion segments after Expansion Segment 15 exceed $1,500 per acre-foot. If all expansion segments below $1,500 per acre-foot are included in Phase III, this Phase will capture approximately 71 percent of the remaining potential demand. A summary of the demands and costs of the Phase III expansion segments is presented in Table 9.6.

Table 9.6 Preferred Alternative – Phase III
Recycled Water Master Plan
Carlsbad Municipal Water District

Expansion Segment	Retrofit AAD(1) (afy)	Ultimate AAD(1) (afy)	Pipeline Length (ft)	Capital Cost(2,3)	Alignment Unit Cost(4) ($/af)
0	126	598	-	$185,000	$20
4A(5)	448	448	700	$485,000	$69
8	520	520	6,500	$1,505,000	$184
3	53	333	8,600	$1,755,000	$335
7	0	64	2,500	$460,000	$458
10	82	82	3,400	$650,000	$504
2	782	782	17,500	$7,700,000	$626
4B	330	330	23,200	$5,220,000	$1,005
9	65	78	5,800	$1,090,000	$894
14	58	58	5,900	$1,070,000	$1,166
15	22	22	2,300	$445,000	$1,319
Total	**2,485**	**3,314**	**76,400**	**20,565,000**	**$378(6)**

Notes:
(1) Phase III AAD includes temporary agricultural demands but excludes development demands, which are not anticipated to be fully in place by the time Phase III is constructed. Ultimate AAD includes development demands, but excludes agricultural demands, which will be replaced by development.
(2) Includes costs for pipelines as well as pressure regulating stations and booster pumping stations as required. These additional facilities are discussed in Section 9.3.1.
(3) Capital Costs include a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent. Cost estimates and cost assumptions are discussed in detail in Chapter 10.
(4) Unit cost assumes a useful life of 50 years and 6.0 percent interest.
(5) Pipeline lengths for Expansion Alternative 4A are not anticipated to be significant due to the utilization of the existing unused failsafe pipeline from Shadowridge.
(6) Overall unit cost for all expansion segments listed as a part of Phase III.

As shown in Table 9.6, it is estimated that Phase III demand of the segments listed in this table will add approximately 3,314 afy of new demand to CMWD's existing recycled water system for a distribution system capital cost of about $20 million.

It is anticipated that the implementation of Phase III will take approximately 10 years, five years for building the infrastructure to support Phase III and five years to connect the customers. The combined unit cost of the expansion segments of Phase III without treatment is estimated at $394 per acre-foot. The total Phase III demand with the existing and near-term demand of 4,100 afy is estimated to reach about 7,414 afy.

9.3.6 Preferred Alternative - Build Out

The remaining expansion segments are included in the Build-Out Phase. Expansion segments recommended for potential incorporation into the Build-Out Phase are listed in Table 9.7.

Table 9.7 Preferred Alternative – Build-out Phase
Recycled Water Master Plan
Carlsbad Municipal Water District

Expansion Segment	Ultimate System Demand (afy)	Pipeline Length (ft)	Capital Cost[1,2]	Alignment Unit Cost[3] ($/af)
4C	582	63,800	$14,820,000	$1,615
16	10	1,400	$265,000	$1,753
1	105	15,400	$3,025,000	$1,833
5	322	54,200	$9,995,000	$1,969
13	32	5,900	$1,145,000	$2,303
18	31	5,400	$1,045,000	$2,145
6	20	3,900	$725,000	$2,330
12[2]	41	8,100	$1,545,000	$2,391
17	85	19,000	$3,410,000	$2,558
11	120	25,700	$4,955,000	$2,614
Total	**1,348**	**202,800**	**$40,930,000**	**$1,927[4]**
Development of Vacant Land	344			
Total with Vacant Land Development	**1,692**			

Notes:
(1) Includes costs for pipelines as well as pressure regulating stations and booster pumping stations as required. Such additional facilities are discussed in Section 9.3.1.
(2) Capital Costs include a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent. Cost estimates and cost assumptions are discussed in detail in Chapter 9.
(3) Unit cost assumes a useful life of 50 years and 6.0 percent interest.
(4) Overall unit cost for all expansion segments.

As shown in Table 9.7, it is anticipated that the segments included in the Build Out Phase will connect about 1,348 afy of potential customer demands for a distribution system capital cost of nearly $41 million. The overall unit conveyance cost of these expansion segments is $1,927 per acre-foot. The appropriate timing on incorporating these more costly system expansions will greatly depend on the future development of potable water cost, availability, and reliability. CMWD should continue monitoring development plans near these expansion segments, as additional potential demands may make these expansion segments more economically viable.

CMWD's service area also includes potential areas of new development for which there is limited information on timing as discussed in Section 3.5.8. Demands for these areas were estimated at 344 afy. The demand for these potential areas of new development was included in the sizing of pipelines and future treatment plant expansions. However, the conveyance cost for serving these vacant areas are not included in the CIP as the onsite development piping is typically paid for by the developers. The alignments shown on the maps may not follow the layout of the eventual tracts and are only intended to show the potential location of developments. The proposed build out system by pressure zone along with the locations of booster pumping stations and pressure regulating stations is shown on Figure 9.7.

9.3.7 Summary of Demand Projections

Based on the phasing of expansion segments discussed previously, the water demands for each phase were estimated as shown in Table 9.8. This table summarizes the projected demands under average annual, average day, and maximum month conditions for each phase.

Table 9.8 Summary of Demands by Phase
Recycled Water Master Plan
Carlsbad Municipal Water District

Phase	Ultimate System Demand (afy)	Average Day Demand (mgd)	Maximum Month Demand[2] (mgd)
Existing + Near Term	**4,100**	**3.7**	**6.3**
Phase III Expansion Segments[1]	3,314	2.9	4.7
Phase III Subtotal	***3,314***	***2.9***	***4.7***
Phase III Total	**7,414**	**6.6**	**11.0**
Build Out Expansion Segments	1,348	1.2	2.0
Development of Vacant Land	344	0.3	0.5
Build-Out Phase Subtotal	***1,692***	***1.5***	***2.5***
Ultimate System Total	**9,106**	**8.1**	**13.5**

Notes:
(1) Assumes that all potential customers adjacent to the existing system are connected during Phase III
(2) MMD peaking factors vary by customer (see Appendix C for details).

As shown in Table 9.8, a total of 9,106 afy of demand was identified as the ultimate system demand. It is estimated that the total Phase III demand would be approximately 7,414 afy.

In addition to a breakdown by phase, demands are presented by service area in relative to CMWD's service area boundary (inside versus outside) in Table 9.9.

Table 9.9	**Potential Demand Outside CMWD's Service Areas** Recycled Water Master Plan Carlsbad Municipal Water District					
	Demand by Agency (afy)					
Phase	**CMWD**	**VID**	**Oceanside**	**VWD**	**OMWD**	**Total**
Existing	4,100	0	0	0	0	4,100
Phase III	1,954	560	218	82	500	3,314
Build-out	746	582	-	20	-	1,348
New Development	344	0	-	-	-	344
Total Ultimate	**7,143**	**1,142**	**218**	**102**	**500**	**9,106**
Not Feasible	11	16	37	455	187	706
Total Potential	**7,155**	**1,158**	**255**	**557**	**687**	**9,812**

As shown in Table 9.9, the new Phase III demand associated with customers inside CMWD's service area is 1,954 afy (59 percent) of the total Phase III demand, while the remaining 1,360 afy (41 percent) is located in the service areas of neighboring agencies.

During the Build-Out Phase, it is estimated that CMWD could serve an additional 746 afy while about half of the demand in this phase (602 afy) is located outside CMWD's service area. This means that under Ultimate System Conditions, approximately 27 percent of the total build out demand of 9,106 afy would be served to customers outside CMWD's service area.

9.3.8 Supply Strategy

As discussed in Chapter 4, the recommended supply alternative consists of the expansion of Carlsbad WRF, abandoning Gafner WRP, and continued utilization of Meadowlark WRF. The recommended supply strategy is to utilize Meadowlark WRF as CMWD's baseline supply and Carlsbad WRF as CMWD's peaking supply while incorporating seasonal storage as possible. Figure 9.8 and Figure 9.9 show how this supply strategy would meet the seasonal variation of demand on a monthly basis under Phase III and Ultimate demand conditions, respectively.

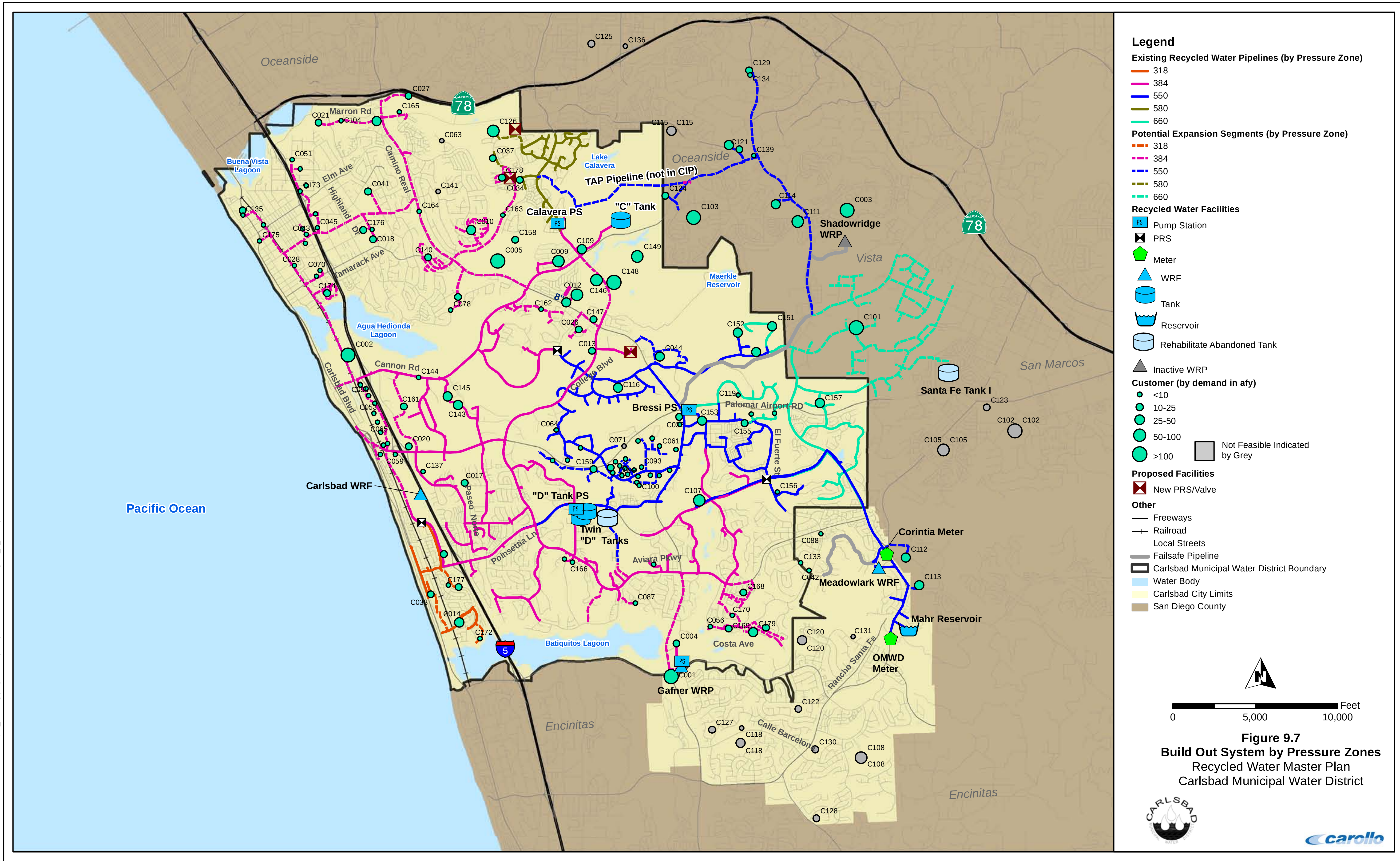

Figure 9.7
Build Out System by Pressure Zones
Recycled Water Master Plan
Carlsbad Municipal Water District

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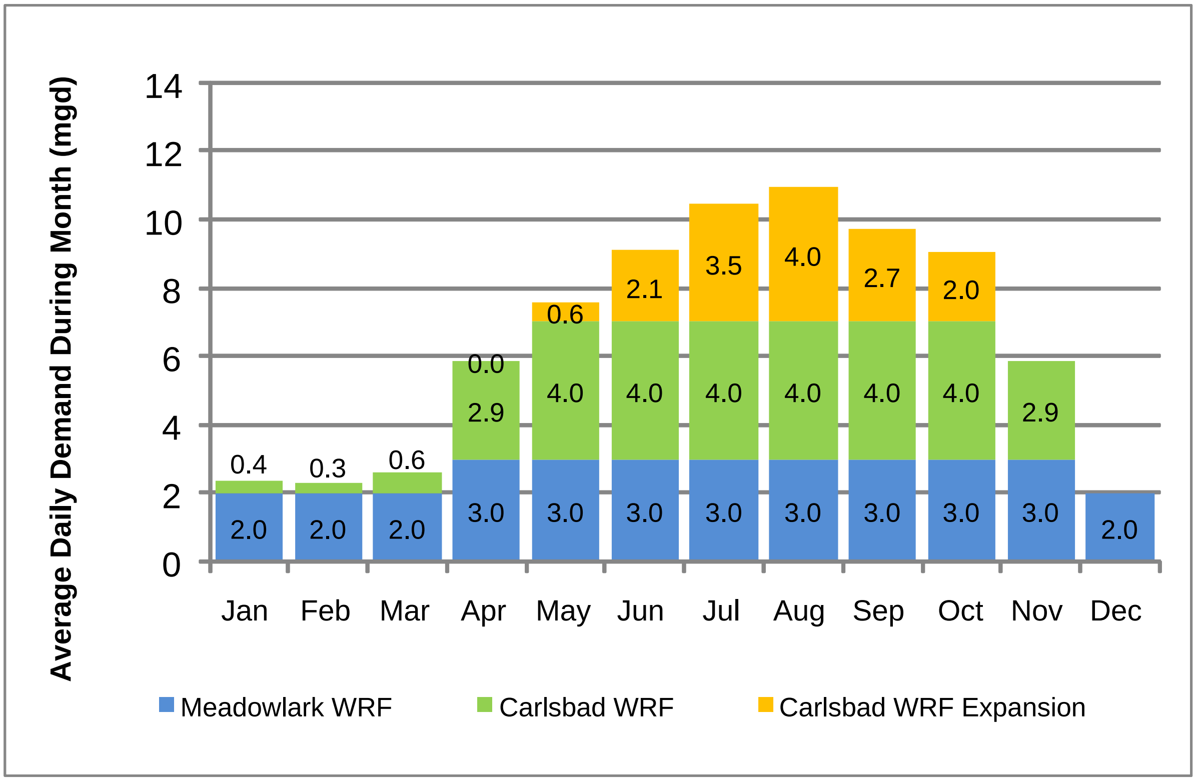

Figure 9.8 Phase III Supply Strategy

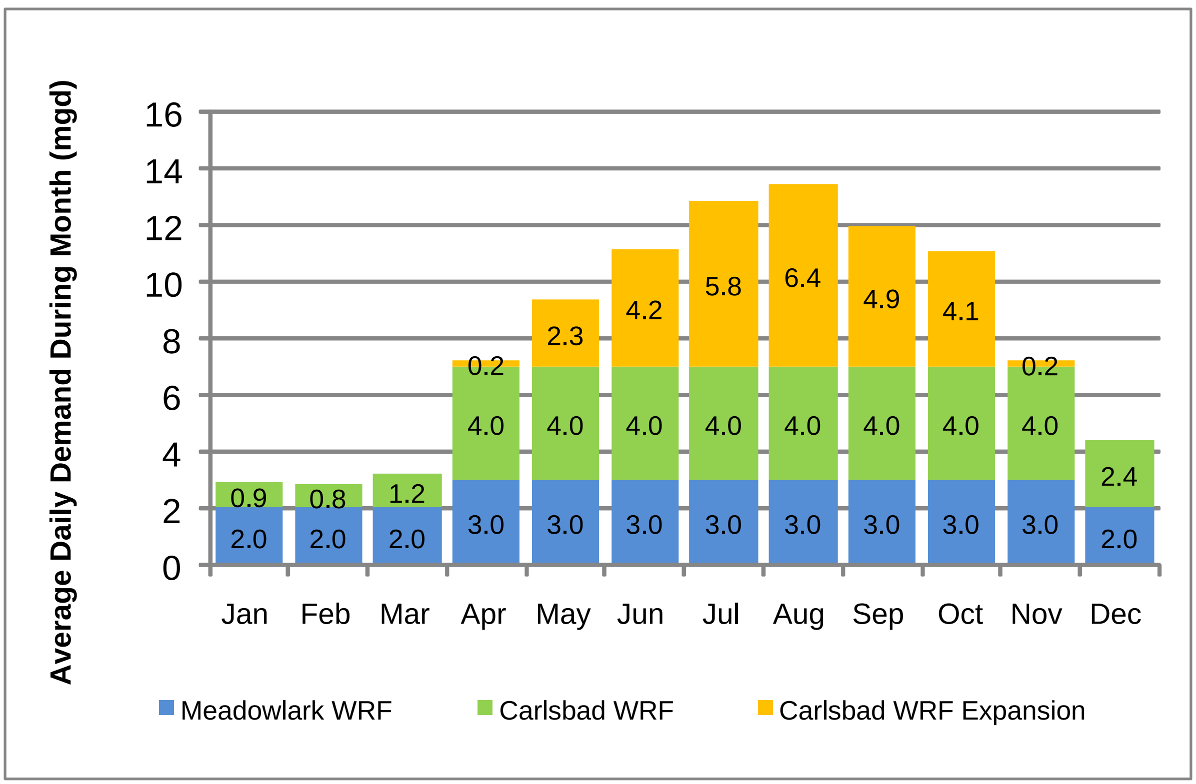

Figure 9.9 Build Out Supply Strategy

As shown in Figure 9.8, the Carlsbad WRF needs to be expanded by about 4.0 mgd to meet the MMD of 11.0 mgd. It is assumed that the existing 4-mgd plant would be expanded by 4 mgd to 8 mgd to meet the Phase III demands. The capital cost, details of which are discussed in Chapter 10, is estimated at $7.0 M. Based on the seasonal peaking factor of 1.7, the existing MMD supply capacity of 7.6 mgd corresponds to an average annual demand of 5,008 afy. Based on an average annual Phase III demand of 7,414 afy, the expansion is assumed to add 2,406 afy of potential demand. Based on an annual demand increase of 2,406 afy made possible by this expansion, the unit cost would be $211 per acre-foot for capital costs.

As shown in Figure 9.9, the Carlsbad WRF needs to be expanded by 6.4 mgd to meet the projected built out demand of 13.5 mgd. For planning purposes, it is assumed that the existing 4-mgd plant would be expanded by 7 mgd, or 3 mgd of additional capacity after completion of Phase III. The estimated capital cost, details of which are discussed in Chapter 10, is estimated at $5.5 M. Based on an average annual build out demand of 9,106 afy, the expansion is assumed to add 1,692 afy of potential demand beyond the capacity of the Phase III system. Based on an annual demand of 1,692 afy made possible by this expansion, the unit cost would be $236 per acre-foot.

Note that the unit cost developed in Chapter 4 is based on a single 7-mgd expansion rather than two expansions, the first phase of 4-mgd and the second phase of 3-mgd.

As discussed in Chapter 4, using seasonal storage in Mahr Reservoir could reduce the required treatment capacity at Carlsbad WRF by about 1 mgd for one month in the entire summer. As shown in Figure 9.10, using Mahr Reservoir as a source of supply in the maximum months can reduce the required build out expansion from 6.4 mgd to 6.0 mgd. However, using seasonal storage to this degree will require very strict accounting and operations of the water in Mahr Reservoir in order to avoid running short on supplies in the maximum month. If demands peak higher in a year due to higher temperatures or low rainfall, supply shortfalls could ensue. It is therefore recommend expanding the Carlsbad WRF by 7 mgd and only using Mahr Reservoir as seasonal and emergency storage backup supply.

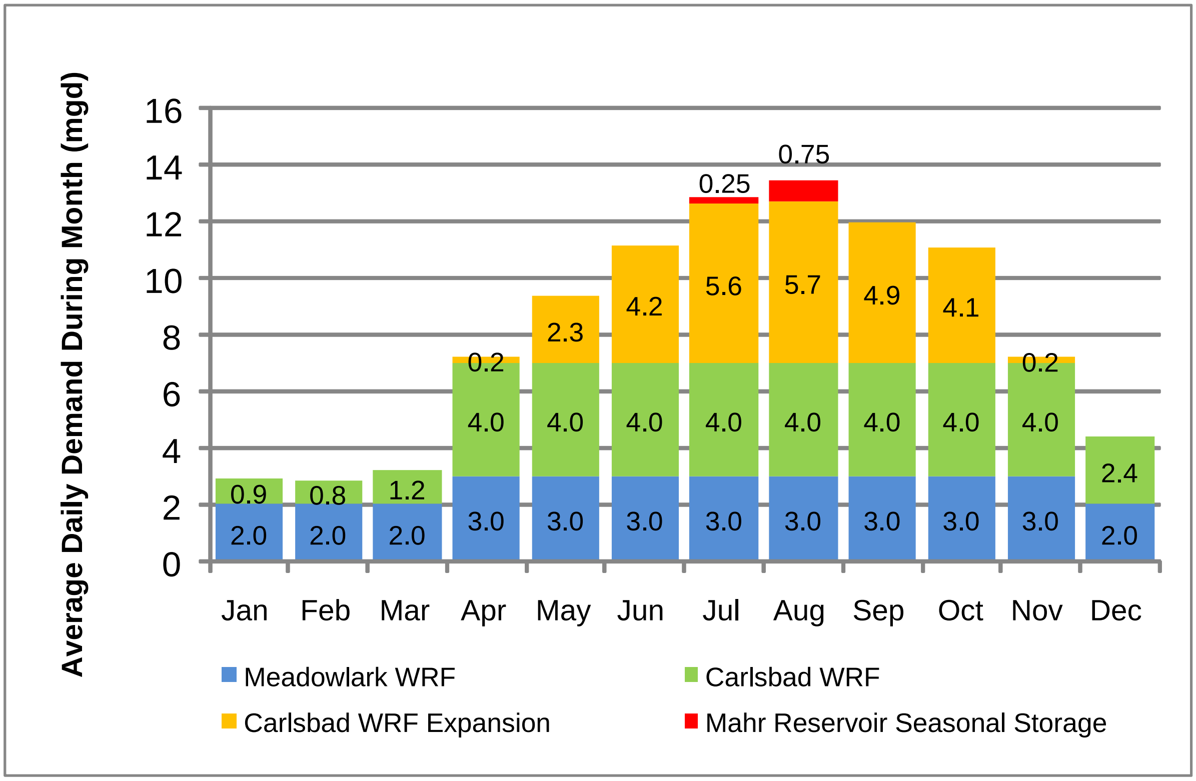

Figure 9.10 Build Out Supply Strategy with Seasonal Storage

9.3.9 Utilization of Abandoned Assets

As discussed in Chapter 2, CMWD has identified several abandoned assets that could potentially be utilized to minimize CMWD's new capital expenditures. This analysis evaluated the potential cost benefit of using the existing abandoned assets.

9.3.9.1 <u>Existing 20-inch Pipeline along El Camino Real</u>

An abandoned 20-inch diameter pipeline runs 3.5 miles along El Camino Real from Faraday Avenue to Chestnut Avenue. The pipeline was originally part of CMWD's potable distribution system. Expansion Segments 3 and 5 include approximately 2.2 miles of 8-inch diameter pipeline following the alignment of the abandoned pipeline.

It is anticipated that utilizing this pipeline would require sliplining the 20-inch diameter abandoned pipeline with an 8-inch diameter pipeline for the recycled water system. The anticipated capital costs associated with utilizing the abandoned asset, along with the anticipated cost savings resulting from not installing a new parallel pipeline, are shown in Table 9.10.

Alignment	Pipeline Segment Length (ft)	Estimated Construction Cost[1]	Capital Cost[2]	Capital Cost without Abandoned Asset[3]	Difference[4]
3	2,300	$200,000	$310,000	$530,000	$220,000
5	9,600	$820,000	$1,255,000	$2,205,000	$950,000
Total	**11,000**	**$1,020,000**	**$1,565,000**	**$2,735,000**	**$1,170,000**

Table 9.10 El Camino Real Abandoned Pipeline Alternative
Recycled Water Master Plan
Carlsbad Municipal Water District

Notes:
(1) Includes costs for sliplining based on unit costs discussed in Chapter 10.
(2) Capital Costs include a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent.
(3) Capital Cost for component of pipeline along El Camino Real that could be substituted by utilization of abandoned asset. This is a portion of the capital cost listed in Table 9.4 for each alternative.
(4) Anticipated savings from utilization of abandoned asset.

As shown in Table 9.10, it is anticipated that utilization of the abandoned pipeline along El Camino Real could result in a cost savings of nearly $1.2 million.

9.3.9.2 Existing 21-inch TAP Connection

A 21-inch diameter pipeline runs across natural open space from College Boulevard to Cannon Road south of Lake Calavera. The pipeline was part of the potable water system and CMWD currently plans to replace this pipeline. This pipeline could be used as an alternative to repurposing the failsafe pipeline in Expansion Segment 4. It is estimated that about 2 miles of the pipeline would be useful as a transmission main for recycled water to supply Oceanside customers (identified as a part of Expansion Segment 4B).

It is anticipated that utilizing this pipeline would require sliplining the 21-inch diameter abandoned pipeline with an 8-inch diameter pipeline for the recycled water system. The anticipated capital costs associated with utilizing the abandoned asset, along with the anticipated additional cost to Expansion Segment 4B, are shown in Table 9.11.

Table 9.11 TAP Connection Alternative
Recycled Water Master Plan
Carlsbad Municipal Water District

Alt.	Pipeline Segment Length (ft)	Estimated Construction Cost(1)	Capital Cost(2)	Original Capital Cost of Alternative 4B	Capital Cost of Alternative 4B with TAP Alternative	Difference
4B	10,800	$920,000	$1,410,000	$5,220,000	$6,630,000	$1,410,000
Total	**10,800**	**$920,000**	**$1,410,000**	**$5,220,000**	**$6,630,000**	**$1,410,000**

Notes:
(1) Includes costs for sliplining based on unit costs discussed in Chapter 10.
(2) Capital costs include a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent.

As shown in Table 9.11, it is anticipated that total capital cost if Alternative 4B was to use the TAP connection would be approximately $6.6 M, a $1.4 M additional cost over using the failsafe pipeline for delivery of recycled water to VID and Oceanside. However, the development of Expansion Segment 4 costs has assumed that the failsafe pipeline will be provided at no cost. This pipeline could serve as an alternative should the pipeline acquisition exceed this cost difference. In addition, if VID customers were not supplied as a part of Expansion Segment 4, the pipeline could serve as an alternative to allow service of Oceanside customers without needing to cross into VID's service area.

Note that, if Expansion Segment 4A is not implemented, this could potentially save the costs of connecting to the failsafe pipeline associated with Expansion Segment 4A.

9.3.10 Redundancy

9.3.10.1 Redundancy Pipeline for Carlsbad Village

Expansion Segments 11 and 12 would be served through a single pipeline from Expansion Segment 2. To limit the potential for service interruptions, Expansion Segment 12 and Expansion Segment 5 could be looped with a 0.5-mile pipeline, allowing for redundancy in supplying the Carlsbad Village area. The estimated capital cost associated with adding this 0.5-mile pipeline is shown in Table 9.12.

Table 9.12 Redundancy Pipeline for Carlsbad Village Recycled Water Master Plan Carlsbad Municipal Water District				
Alignment	**Diameter (in)**	**Pipeline Length (ft)**	**Estimated Construction Cost(1)**	**Capital Cost(2)**
Chestnut Ave. from Valley Street to El Camino Real	12	4,200	$630,000	$965,000

Notes:
(1) Based on unit costs discussed in Chapter 10.
(2) Capital costs include a construction cost contingency of 20 percent and additional markups for engineering and legal costs of 27.5 percent.

As shown in Table 9.12, it is anticipated that total capital cost for a pipeline between Expansion Segments 5 and 12 would be approximately $1.0 M.

9.3.10.2 Supply of Full System without Meadowlark WRF

CMWD currently has the capability to maintain full supply of its recycled water system under MMD conditions with the ultimate supply capacity of Carlsbad WRF and with the supplemental potable connection at the Twin D Tanks, while Meadowlark WRF is offline. This analysis evaluates the additional capacity necessary to supply MDD conditions under built out conditions with Meadowlark WRF offline and the Gafner WRP no longer available. The results are shown in Table 9.13.

Table 9.13 Analysis of Supply without Meadowlark WRF Recycled Water Master Plan Carlsbad Municipal Water District		
Source	**Built Out Capacity/Demand (mgd)**	**Built Out Capacity/Demand(1) (gpm)**
Ultimate Carlsbad WRF	11.0	7,600
Potable Supplement	4.3	3,000
Total	**15.3**	**10,600**
Maximum Month Demand(2)	13.5	9,400
Balance	**+1.8**	**+1,200**

Notes:
(1) Although capacity is shown in units of gpm, supplies are calculated for maximum month demand conditions. Operational storage to accommodate daily peaking is discussed in Section 9.3.11.
(2) MMD from build-out system including areas of potential development and neighboring agencies in addition to potential customers identified within CMWD's service area.

As discussed in Chapter 2, the existing potable water connection can supply 3,000 gpm of supplement water. Based on the supply analysis presented in Section 9.3.8, the ultimate supply capacity of Carlsbad WRF is recommended to be increased from 4 to 11 mgd.

As Zone 550 and Zone 660 typically receive flow from Meadowlark WRF, the Twin D pump station must be sized to meet demands of both of these zones (as the potable supplement connection and the Carlsbad WRF feeds Zone 384). Table 9.14 presents an analysis of the capacity of the Twin D pump station under ultimate demand conditions. This analysis is conducted under MMD conditions since operational storage is recommended to be incorporated into Zone 550 to accommodate daily peaking (see Section 9.3.11).

Table 9.14 Twin D Capacity Analysis
Recycled Water Master Plan
Carlsbad Municipal Water District

Booster Station	Existing Pump Station Capacity (gpm)	Built Out Zone 550 and 660 MMD (mgd)	Built Out Zone 550 and 660 MMD(1) (gpm)
Twin D	4,500	4.9	3,400

Notes:
(1) As discussed in Section 9.3.11, operational storage is recommended to be included in Zone 550 to accommodate daily peaking.

As shown in Table 9.14, the existing capacity of the Twin D pump station is sufficient to meet Maximum Day Demands for Zones 550 and 660 of the built out system. It should be noted that the pump station cannot accommodate peak hour demands of Zones 550 and 660. As discussed in Section 9.3.11, the storage analysis recommends operational storage within Zones 550 and 660.

9.3.11 Storage Analysis

The storage analysis evaluates the existing storage capacity based on the evaluation criteria in Chapter 7 for operational and emergency storage. A definition for each category of storage criteria is summarized below.

- Operational Storage: The storage required to buffer demand fluctuations under maximum day demand (MDD) conditions. The required operational storage is defined as 33 percent of MDD.
- Short-term Emergency Storage: The storage volume required for preventing a reservoir from completely draining during an emergency situation such as a temporary supply outage or a demand spike. The required emergency storage is defined as 17 percent of MDD.

A third component of storage used in CMWD's system, seasonal storage, is treated as a source of supply and is discussed in more detail in Chapter 4.

As described in Chapter 8, CMWD currently has 35.5 MG of storage, 32.0 MG of which is available in Mahr Reservoir.

Operational and emergency storage requirements were calculated based on the evaluation criteria. Demands for Zone 742 (La Costa Ridge) are incorporated into Zone 550. For Zones 318 and 580, the reservoir capacity is assumed to be located in the larger Zone 384, from which each of these zones will be supplied. For Zones 550 and 660, demand in the existing system does not require operational storage as Meadowlark WRF supplies a greater flow than the demand of Zones 550 and 660. However, for the future system, it is anticipated that storage will be required for Zones 550 and 660 once demands in Zones 550 and 660 exceed available supply from Meadowlark WRF on a MMD basis.

Note that demands for the La Costa Resort and Spa south golf course are incorporated into Zone 384, since the recommended supply alternative would include abandonment of Gafner WRP; although currently, operational storage for the La Costa Resort and Spa south golf course is provided by on-site ponds. Total future required operational and emergency storage requirements are compared to the existing storage in Table 9.15.

Table 9.15 Storage Capacity Evaluation for Build-out
Recycled Water Master Plan
Carlsbad Municipal Water District

Zone	Built Out MMD (mgd)	Operational Storage(1,2) (MG)	Short-Term Emergency Storage(1,3) (MG)	Total Required Storage (MG)	Existing Storage (MG)	Balance (MG)
660	0.6	0.2	0.1	0.3	0.0(4)	-0.3
550	4.2	1.4	0.7	2.1	0.0(4)	-2.1
Subtotal	***4.8***	***1.6***	***0.8***	***2.4***	***0.0(4)***	***-2.4***
Subtotal w/ Mahr	***4.8***	***1.6***	***0.8***	***2.4***	***32.0(4)***	***+29.6***
580	0.4	0.2	0.1	0.2	0.0	-0.2
384	8.0	2.7	1.4	4.0	3.5	-0.5
318	0.2	0.1	< 0.1	0.1	0.0	-0.1
Subtotal	***8.7***	***2.9***	***1.5***	***4.3***	***3.5***	***-0.8***
Total w/o Mahr	**13.5**	**4.4**	**2.3**	**6.7**	**3.5**	**-3.2**
Total w/ Mahr	**13.5**	**4.4**	**2.3**	**6.7**	**35.5**	**+28.8**

Notes:
(1) Operational and Emergency Storage requirements are based on the evaluation criteria from Chapter 7.
(2) Based on the evaluation criteria, Operational Storage is 33 percent of the MMD.
(3) Based on the evaluation criteria, Emergency Storage is 17 percent of the MMD, or four hours.
(4) Supplies from Meadowlark WRF are taken at a constant rate greater than the demand of Zones 550 and 660. Consequently, Operational Storage for Zone 550 is not needed. When necessary, Mahr Reservoir can be used to buffer supplies at Meadowlark WRF.

As shown in Table 9.15, a deficit of 3.2 MG is anticipated at build-out if capacity in Mahr Reservoir is not considered.

Zone 550 and Zone 660 is grouped together as these zones are both fed from Meadowlark WRF. As shown in Table 9.15, a total storage volume of 2.4 MG is required for these zones. If there is sufficient MMD supplies such that capacity within Mahr Reservoir is not needed for seasonal storage, the required storage could be satisfied through use of Mahr Reservoir, assuming CMWD develops a method of replenishing Mahr Reservoir from its other supply sources (since daily demand in Zone 550 and Zone 660 will exceed supply from Meadowlark WRF). Otherwise, it is recommended that the ultimate system include 2.5 MG of new storage capacity for Zone 550. This can be met by rehabilitating the 2.5 MG Santa Fe I tank in Zone 660.

Note that the demands for expansion segment Alternative 4C are used to calculate this storage requirement. The total required storage volume will be significantly less if Alternative 4C is not implemented.

Zones 318, 384, and 580, as well as proposed Zones 425 and 742, are grouped together as these zones are all planned to be fed from Carlsbad WRF (Zone 384). As shown in Table 9.15, a total of 0.8 MG of storage is required for these zones. The hydraulic model predicted a significant decline in zone hydraulic grade line (HGL) across the pressure zone during peak hour demand conditions, especially to the north of the zone. The C Tank was predicted to empty during peak periods. As mentioned in Chapter 2, the base elevation of the C Tank is approximately 8 feet above the zone HGL of 384 ft-msl. This may result in the need for an additional storage reservoir in the north of the system.

While rehabilitating the Santa Fe I tank would resolve the shortage shortfall anticipated at build out (excluding Mahr Reservoir), it is most likely not cost effective to connect to the Santa Fe I tank until Expansion Segment 4C is constructed. As Expansion Segment 4C is not part of Phase III, as separate storage analysis for Phase III was conducted, which is summarized in Table 9.16.

As shown in Table 9.16, a storage shortfall of 2.0 MG is anticipated for Phase III when Mahr Reservoir is not included. Based on the assumption that CMWD would maintain operational storage within its distribution system under its control, additional storage is recommended to be placed at the existing Twin D tank site, sized at 2 MG. With this additional storage, PHD could then be supplied to Zones 550 and 660 from the Twin D storage. At build out, it is recommended to also rehabilitate the Santa Fe I tank and use this for storage. Hence, a total of 4.5 MG of new storage is recommended and included in the CIP.

Alternatively, CMWD can use Mahr Reservoir or equalization basins at Carlsbad WRF to meet the deficit during Phase III and add storage in build out through rehabilitation of the Santa Fe I tank. However, to maintain control of storage within CMWD's distribution system, the recommendation of this report is to add 2 MG of storage at the Twin D tank site as a part of Phase III and rehabilitate the Santa Fe I tank as a part of the build out phase.

Table 9.16 Storage Capacity Evaluation for Phase III
Recycled Water Master Plan
Carlsbad Municipal Water District

Zone	MMD (mgd)	Operational Storage[1,2] (MG)	Short-Term Emergency Storage[1,3] (MG)	Total Required Storage (MG)	Existing Storage (MG)	Balance (MG)
660	0.6	0.2	0.1	0.3	0.0	-0.3
550	2.9	1.0	0.5	1.5	0.0	-1.5
Subtotal	***3.6***	***1.2***	***0.6***	***1.8***	***0.0***	***-1.8***
Subtotal w/ Mahr	***3.6***	***1.2***	***0.6***	***1.8***	***32.0***	***+30.2***
580	0.4	0.2	0.1	0.2		-0.2
384	6.8	2.2	1.2	3.4	3.5	+0.1
318	0.2	0.1	0.0	0.1		-0.1
Subtotal	***7.4***	***2.4***	***1.3***	***3.7***	***3.5***	***-0.2***
Total w/o Mahr	**11.0**	**3.6**	**1.9**	**5.5**	**3.5**	**-2.0**
Total w/ Mahr	**11.0**	**3.6**	**1.9**	**5.5**	**35.5**	**+30.0**

Notes:
(1) Operational and Emergency Storage requirements are based on the evaluation criteria from Chapter 7.
(2) Based on the evaluation criteria, Operational Storage is 33 percent of the MMD.
(3) Based on the evaluation criteria, Emergency Storage is 17 percent of the MMD, or four hours.

9.3.12 Pump Station Analysis

This analysis compares the capacity of each existing pump station to the corresponding built out demands to determine whether additional pumping capacity is required. Table 9.17 presents a summary of this analysis.

Table 9.17 Ultimate Pump Station Capacity Analysis
Recycled Water Master Plan
Carlsbad Municipal Water District

Booster Pumping Station	Pressure Zone	MMD (mgd)	MMD (gpm)	Required Capacity (gpm)	Firm Capacity (gpm)	Balance (gpm)
Bressi PS	660	0.6	448	952	3,000	+2,552
Calavera PS	580	0.4	312	935(1)	1,200	+265
Twin D PS	550, 660	4.8	3,341	3,371	4,500	+1,159
Carlsbad WRF PS(2,3)	all	14.0	9,722	9,722	10,000	+278

Notes:
(1) No operational storage for daily peaking is included for Calavera PS in Zone 580. A peaking factor of 3.0 was applied.
(2) For reliability purposes it is assumed that this PS needs be able to supply the system wide MMD with Meadowlark WRF out of service.
(3) CMWD does not plan for standby pumping capacity at Carlsbad WRF.

As shown in Table 9.17, all pump stations have sufficient pumping capacity to meet the projected demands. Hence, no pump station expansions are included in the CIP.

Note that as Carlsbad WRF has occasionally been used in the past to serve PHD, if CMWD maintains the capability for supplying PHD from Carlsbad WRF, additional capacity may be required. The recommendation of this report is to maintain MMD pumping capacity. Hence, no pump station expansions are included in the CIP.

9.4 SUMMARY OF FUTURE SYSTEM RECOMMENDATIONS

9.4.1 Distribution System

The recommendations detailed in this chapter are summarized in Table 9.18. Detailed cost estimates for each of these recommendations are included in the capital improvement program (CIP), which is presented in Chapter 10.

Table 9.18 Future System Recommendations
Recycled Water Master Plan
Carlsbad Municipal Water District

Phase	Description	Category	Size/Capacity
Phase III	Expansion Alignment 2	Pipeline	17,500 feet
Phase III	Expansion Alignment 3	Pipeline	8,600 feet
Phase III	Expansion Alignment 4A	Pipeline	1 vault
Phase III	Expansion Alignment 4A	Pipeline	700 feet
Phase III	Expansion Alignment 4B	Pipeline	23,200 feet
Phase III	Expansion Alignment 7	Pipeline	2,500 feet
Phase III	Expansion Alignment 8	Pipeline	6,500 feet
Phase III	Expansion Alignment 9	Pipeline	5,800 feet
Phase III	Expansion Alignment 10	Pipeline	3,400 feet
Phase III	Expansion Alignment 14	Pipeline	5,900 feet
Phase III	Expansion Alignment 15	Pipeline	2,300 feet
Phase III	Zone 384 Reservoir	Storage	2 MG
Phase III	Increase Capacity of Carlsbad WRF	Treatment	4 mgd
Build-out	Expansion Alignment 1	Pipeline	15,400 feet
Build-out	Expansion Alignment 4C	Pipeline	63,800 feet
Build-out	Expansion Alignment 5	Pipeline	54,200 feet
Build-out	Expansion Alignment 6	Pipeline	3,900 feet
Build-out	Expansion Alignment 11	Pipeline	25,700 feet
Build-out	Expansion Alignment 12	Pipeline	8,100 feet
Build-out	Expansion Alignment 13	Pipeline	5,900 feet
Build-out	Expansion Alignment 16	Pipeline	1,400 feet
Build-out	Expansion Alignment 17	Pipeline	19,000 feet
Build-out	Expansion Alignment 18	Pipeline	5,400 feet
Build-out	Redundancy Pipeline Carlsbad Village	Pipeline	4,200 feet
Build-out	Slipline Pipeline to Santa Fe Tank I	Pipeline	3,600 feet
Build-out	Increase Capacity of Carlsbad WRF	Treatment	3 mgd
Build-out	Rehabilitate Santa Fe Tank I	Storage	2.5 MG

CAPITAL IMPROVEMENT PROGRAM

10.1 INTRODUCTION

The purpose of this chapter is to provide the Carlsbad Municipal Water District (CMWD) with a phased capital improvement program (CIP) that will guide CMWD with the implementation of recycled water system expansions in an effort to offset potable water demand requirements as much as possible.

The previous chapter proposed a recommended recycled water system. In this chapter, cost assumptions are presented, followed by a description of the proposed Phase III and Build Out systems, and the proposed project phasing. This chapter is concluded with an estimate of the costs of the recommended CIP.

10.2 COST ESTIMATING ASSUMPTIONS

10.2.1 Scope and Accuracy Range

The cost estimating criteria presented herein develop a consistent methodology for comparing alternatives. This methodology allows for different alternatives to be evaluated on the same cost basis.

Cost estimates presented in this master plan are based on the current Engineering and News Record (ENR) 20 cities cost index of 9,035 published in May 2011. Future adjustments of cost estimates presented in this report can be estimated by increasing the estimated capital cost by the ratio of the future ENR to 9,035.

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. The actual costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as preliminary alignment generation, detailed utility surveys, and environmental and local considerations.

The Association for the Advancement of Cost Engineering (AACE) defines an order-of-magnitude estimate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within +50 percent to -30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

The AACE International defines five different class estimate categories as summarized in Table 10.1.

Table 10.1	Class Estimates Recycled Water Master Plan Carlsbad Municipal Water District		
Class	**Status of Design**	**Accuracy Range**	
		Low Side	**High Side**
5	N/A	-20% to -50%	+30% to +100%
4	1% to 5%	-15% to -30%	+20% to +50%
3	10% to 40%	-10% to -20%	+10% to +30%
2	30% to 70%	-5% to -15%	+5% to +20%
1	80% to 110%	-3% to -10%	+3% to +15%
5	Rough Order-of-Magnitude Planning Estimate		
4	Detailed Planning Level Estimate		
3	Project Budget Estimate		
2	Detailed Project Control Estimate		
1	Bid Check Estimate		

Note:
Percentages are based on the construction cost value and not on an incremental subtotal after each percentage category

The budgeting level estimates needed for planning purposes and CIPs are usually based on Class 5, and as such, the costs developed in this master plan shall be considered Class 5 estimates, unless noted otherwise. A definition of the five different class estimates is described below.

Class 5. This estimate is considered as rough order-of-magnitude estimate. It is usually prepared based on limited information, where little more than proposed facility type, its location, and the capacity are known. Strategic planning purposes include, but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would be cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. Little time is expended in the development of this estimate. The typical expected accuracy range for this class estimate is -20 to -50 percent on the low side and +30 to +100 percent on the high side.

Class 4. This estimate is prepared based on information where the preliminary engineering is 1 to 5 percent complete. Detailed strategic planning, business development, project screening, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval are needed to proceed with this class estimate. Examples of estimating methods used would include equipment and/or system process factors, scale-up factors, as well as parametric and modeling techniques. This estimate requires more time to develop. The typical expected accuracy range for this class estimate is -15 to -30 percent on the low side and +20 to +50 percent on the high side.

A Class 4 estimate may also be justified by the methods presented for this cost evaluation if suitable definitions of project components, individual consideration of special project components/conditions, and independent cost verifications are conducted. Commensurate reductions in project contingencies should also be considered for the Class 4 estimate.

The following class estimates are typically used during the preliminary and final design stages of a project and are not applicable to estimates developed using this estimating guide. They are described in this report for information and consistency. These estimate classes include Class 3, Class 2, and Class 1:

Class 3. This estimate is prepared to form the basis for the project authorization, and/or funding. Typically, engineering is 10 to 40 percent complete, and would comprise process flow diagrams, preliminary piping runs for major processes, facility layout drawings, and complete process and facility equipment lists. This estimate becomes the project control or project budget estimate until more detailed estimates are completed. Examples of methods used would be a high degree of detailed unit cost, and quantity takeoffs for major processes. Factoring and/or scale-up factors can be used for less significant or support areas of the project. This estimate requires a great deal of time to prepare, where actual equipment and processes have been designed. The typical expected accuracy range for this class estimate is -10 to -20 percent on the low side, and +10 to +30 percent on the high side.

Class 2. This estimate is prepared to form a detailed control baseline for the project. Typically, engineering is 30 to 70 percent complete, and would comprise process flow diagrams, piping and instrument runs for all processes, final facility layout drawings, complete process and facility equipment lists, single-line diagrams for electrical components, and schedules. This estimate becomes the detailed project control estimate. Examples of methods used include a high degree of deterministic estimating, as well as detailed quantity takeoffs for all facility processes and/or systems, with little factoring and/or scale-up factors used, except for minor project support areas. This estimate usually becomes the final estimate and requires a great deal of line-item information, which can take significant time to prepare. The typical expected accuracy ranges for this class estimate are -5 to -15 percent on the low side and +5 to +20 percent on the high side.

Class 1. This estimate is prepared to confirm the control baseline for the project. Typically, engineering is 80 to 100 percent complete, which comprises virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. This estimate becomes the final control baseline of the project. Examples of methods used are the highest degree of deterministic estimating, with very detailed quantity takeoffs for all facility processes and/or systems of the project. This type of estimate usually becomes the bid check estimate and can require the most effort to create. The typical expected accuracy ranges for this class estimate are -3 to -10 percent on the low side and +3 to +15 percent on the high side.

All classes of cost estimates described, and any resulting conclusions on project financial or economic feasibility or funding requirements, are prepared for guidance in project evaluation and implementation. The final costs of the project, and resulting feasibility, will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate developed using the information in this master plan. Because of these factors, project feasibility, cost-benefit ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

This evaluation is concerned only with estimates at the planning and conceptual phase of the projects for CMWD. Therefore, only Class 5 estimates have been developed. For the development of the CIP, a construction cost contingency and other markups will be applied consistent with Table 10.2. The markups are intended to account for costs of engineering, design, administration, and construction management.

10.2.2 Markups and Contingency

The cost estimates are based on current perceptions of conditions at the project locations. These estimates reflect Carollo's professional opinion of costs at this time and are subject to change as the project details are defined. Carollo has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding, or market conditions, practices, or bidding strategies. Carollo cannot, and does not, warrant or guarantee that proposals, bids, or actual construction costs will not vary for the costs presented as shown.

Table 10.2	**General Cost Estimating Assumptions** Recycled Water Master Plan Carlsbad Municipal Water District
Description	**Percent of Construction Cost**
Construction Cost	100.0%
Construction Cost Contingency	20.0%
Construction Cost + Contingency	**120.0%**
Engineering and Design	10.0%
Project Administration	2.5%
Construction Management	5.0%
Construction Inspection	10.0%
Total Markups	**127.5%**
Total Project Cost[1]	**153.0%**

Note:
(1) Percentages are based on the construction cost value and not on an incremental subtotal after each category. Total Project Cost = Construction Cost + Contingency x Total Markups.

10.2.3 Unit Construction Costs

The construction cost estimates presented in this report are based on the unit construction costs listed in Table 10.3. Construction costs for recycled water system pipelines include pipe material, valves, appurtenances, excavation, installation, bedding material, backfill material, transport, and paving where applicable. The costs of acquiring easements for pipeline construction are not included in the estimates presented in this report.

Table 10.3	**Unit Construction Cost** Recycled Water Master Plan Carlsbad Municipal Water District
Category	**Unit Construction Cost**
Pipelines	**$/lineal ft**
4-inch diameter	100
6-inch diameter	110
8-inch diameter	120
12-inch diameter	150
16-inch diameter	290
18-inch diameter	350
20-inch diameter	400
24-inch diameter	500
30-inch diameter	650
36-inch diameter	750

Table 10.3 **Unit Construction Cost** Recycled Water Master Plan Carlsbad Municipal Water District	
Category	**Unit Construction Cost**
Special Pipeline Construction	**Markup (%) or $/lineal ft**
Slip-lining[(1)] (8" into a 21")	$85 /lineal ft
Booster Pumping Stations – New Construction	**$/hp**
< 100 hp	$6,000
100 to < 500 hp	$4,500
500 hp and greater	$3,500
Storage	**$/gallon**
< 1 MG	$2.00
1 to < 2 MG	$1.75
2 to < 5 MG	$1.50
5 MG and greater	$1.25
Miscellaneous	**$/unit**
Customer Laterals	$4,000 $/lateral
Enclosure Structures	$300 $/sf
PRV (in pre-existing vault)	$50,000 $/station

Note:
(1) The unit cost for sliplining was developed based on the elevation differences, diameter, and length of the TAP connection. It is assumed that the unit construction costs would be similar for the other projects requiring sliplining of existing pipelines.

For booster pumping stations (PS), unit costs are included based on the required horsepower assuming the project involves a new PS requiring new piping and all associated appurtenances. If a PS project only requires the replacement or addition of a pump to an existing PS, the unit costs will be evaluated on a per site basis at that time. Unit costs for PSs are estimated per horsepower of design size.

10.2.4 Excluded Costs

There are several other components that may be needed to support the development of major water supply facilities. Since most of these items are unique and project specific, they should be applied on a project-by-project basis. Therefore, no unit costs were included in Table 10.3 for the following items:

- **Land acquisition.** Cost for purchasing land or right of way are not included due to variability of real estate market conditions.
- **Power transmission lines.** The cost of these to support a major pumping or treatment is often on a shared cost basis with the power utility.
- **Maintenance roads.** If pipelines are installed in remote areas, maintenance roads are sometimes required to access the facilities.

- **Overall program management.** If the sheer magnitude of the capital cost program exceeds the capacity of City of Carlsbad staff to manage all of the work, then the services of a program management team may be required.
- **Public information program.** Depending on the relative public acceptability of a major water facility or a group of facilities, there may be a need for a public information program, which could take many different shapes.
- **Customer retrofits.** Retrofit costs are associated with separating the customer's existing potable water system from a new recycled water system. An example would be a park where restroom and drinking fountain water supply pipes would need to be isolated from an existing irrigation system. Additional costs include posting signage, which identifies where recycled water is being used. Customer retrofits are one-time costs and are dependent upon the complexity of existing irrigation systems at each individual site. This cost estimate excludes cost of customer retrofits.
- **Foundation requirements.** Foundation reinforcement or support requirements are very site specific with regard to necessary method and type, and a geotechnical study is typically needed to determine such requirements. These costs, therefore, have not been included in any of the unit cost curves.
- **Other costs.** These costs may be necessary on some projects and could include environmental mitigation and permitting costs; special legal, administrative, or financial assistance; easements or rights-of-way and land acquisition costs; and expediting costs, such as separate material procurement contracts. These *other* costs typically range from 5 to 15 percent of construction cost.

10.3 SUMMARY OF RECOMMENDATIONS

This section summarizes the projects recommended in Chapter 8 (Existing System Analysis) and Chapter 9 (Future System Analysis). The detailed cost estimate for each component of each project is presented followed by a summary of the cost estimate data by project type and phase.

10.3.1 Project Cost Estimates

Table 10.4 presents the detailed cost estimate for each component of the projects based on the recommended projects and quantities described in Chapters 8 and 9 and the unit costs presented in Table 10.3.

Table 10.4 Detailed Project List
Recycled Water Master Plan
Carlsbad Municipal Water District

Project ID	Category	Description	Planning Phase	Size	Unit	Capacity		Unit Cost		Construction Cost	Capital Cost
P01	Pipeline	Expansion Alignment 1	Build-out	3,100	ft	4	in	100	$ per lineal ft	$310,000	$475,000
P02	Pipeline	Expansion Alignment 1	Build-out	5,200	ft	6	in	110	$ per lineal ft	$575,000	$880,000
P03	Pipeline	Expansion Alignment 1	Build-out	7,100	ft	8	in	120	$ per lineal ft	$855,000	$1,310,000
P04	Pipeline	Expansion Alignment 1	Build-out	58	meters			4,000	$ per meter	$235,000	$360,000
P05	Pipeline	Expansion Alignment 2	Phase III	1,300	ft	6	in	110	$ per lineal ft	$145,000	$225,000
P06	Pipeline	Expansion Alignment 2	Phase III	3,700	ft	8	in	120	$ per lineal ft	$445,000	$685,000
P07	Pipeline	Expansion Alignment 2	Phase III	3,900	ft	12	in	150	$ per lineal ft	$585,000	$900,000
P08	Pipeline	Expansion Alignment 2	Phase III	200	ft	16	in	290	$ per lineal ft	$60,000	$95,000
P09	Pipeline	Expansion Alignment 2	Phase III	4,900	ft	20	in	400	$ per lineal ft	$1,960,000	$3,000,000
P10	Pipeline	Expansion Alignment 2	Phase III	3,500	ft	24	in	500	$ per lineal ft	$1,750,000	$2,680,000
P11	Pipeline	Expansion Alignment 2	Phase III	18	meters			4,000	$ per meter	$75,000	$115,000
P12	Pipeline	Expansion Alignment 3	Phase III	3,000	ft	6	in	110	$ per lineal ft	$330,000	$505,000
P13	Pipeline	Expansion Alignment 3	Phase III	1,400	ft	8	in	120	$ per lineal ft	$170,000	$265,000
P14	Pipeline	Expansion Alignment 3	Phase III	4,200	ft	12	in	150	$ per lineal ft	$630,000	$965,000
P15	Pipeline	Expansion Alignment 3	Phase III	2	meters			4,000	$ per meter	$10,000	$20,000
P16	Pipeline	Expansion Alignment 4A	Phase III	2	interc.			100,000	$ per conn.	$200,000	$310,000
P17	Pipeline	Expansion Alignment 4A	Phase III	700	ft	12	in	150	$ per lineal ft	$105,000	$165,000
P18	Pipeline	Expansion Alignment 4A	Phase III	1	meters			4,000	$ per meter	$5,000	$10,000
P19	Pipeline	Expansion Alignment 4B	Phase III	500	ft	4	in	100	$ per lineal ft	$50,000	$80,000
P20	Pipeline	Expansion Alignment 4B	Phase III	4,000	ft	6	in	110	$ per lineal ft	$440,000	$675,000
P21	Pipeline	Expansion Alignment 4B	Phase III	5,400	ft	8	in	120	$ per lineal ft	$650,000	$995,000
P22	Pipeline	Expansion Alignment 4B	Phase III	11,700	ft	12	in	150	$ per lineal ft	$1,755,000	$2,690,000
P23	Pipeline	Expansion Alignment 4B	Phase III	1,600	ft	16	in	290	$ per lineal ft	$465,000	$715,000
P24	Pipeline	Expansion Alignment 4B	Phase III	9	meters			4,000	$ per meter	$40,000	$65,000
P25	Pipeline	Expansion Alignment 4C	Build-out	2,600	ft	4	in	100	$ per lineal ft	$260,000	$400,000
P26	Pipeline	Expansion Alignment 4C	Build-out	22,600	ft	6	in	110	$ per lineal ft	$2,490,000	$3,810,000
P27	Pipeline	Expansion Alignment 4C	Build-out	11,400	ft	8	in	120	$ per lineal ft	$1,370,000	$2,100,000

Table 10.4 Detailed Project List
Recycled Water Master Plan
Carlsbad Municipal Water District

P28	Pipeline	Expansion Alignment 4C	Build-out	27,200	ft	12	in	150	$ per lineal ft	$4,080,000	$6,245,000
P29	Pipeline	Expansion Alignment 4C	Build-out	369	meters			4,000	$ per meter	$1,480,000	$2,265,000
P30	Pipeline	Expansion Alignment 5	Build-out	7,000	ft	4	in	100	$ per lineal ft	$700,000	$1,075,000
P31	Pipeline	Expansion Alignment 5	Build-out	9,300	ft	6	in	110	$ per lineal ft	$1,025,000	$1,570,000
P32	Pipeline	Expansion Alignment 5	Build-out	33,700	ft	8	in	120	$ per lineal ft	$4,045,000	$6,190,000
P33	Pipeline	Expansion Alignment 5	Build-out	4,200	ft	12	in	150	$ per lineal ft	$630,000	$965,000
P34	Pipeline	Expansion Alignment 5	Build-out	31	meters			4,000	$ per meter	$125,000	$195,000
P35	Pipeline	Expansion Alignment 6	Build-out	2,100	ft	6	in	110	$ per lineal ft	$235,000	$360,000
P36	Pipeline	Expansion Alignment 6	Build-out	1,800	ft	8	in	120	$ per lineal ft	$220,000	$340,000
P37	Pipeline	Expansion Alignment 6	Build-out	3	meters			4,000	$ per meter	$15,000	$25,000
P38	Pipeline	Expansion Alignment 7	Phase III	2,500	ft	8	in	120	$ per lineal ft	$300,000	$460,000
P39	Pipeline	Expansion Alignment 8	Phase III	6,500	ft	12	in	150	$ per lineal ft	$975,000	$1,495,000
P40	Pipeline	Expansion Alignment 8	Phase III	1	meters			4,000	$ per meter	$5,000	$10,000
P41	Pipeline	Expansion Alignment 9	Phase III	1,600	ft	6	in	110	$ per lineal ft	$180,000	$280,000
P42	Pipeline	Expansion Alignment 9	Phase III	4,200	ft	8	in	120	$ per lineal ft	$505,000	$775,000
P43	Pipeline	Expansion Alignment 9	Phase III	4	meters			4,000	$ per meter	$20,000	$35,000
P44	Pipeline	Expansion Alignment 10	Phase III	3,400	ft	8	in	120	$ per lineal ft	$410,000	$630,000
P45	Pipeline	Expansion Alignment 10	Phase III	2	meters			4,000	$ per meter	$10,000	$20,000
P46	Pipeline	Expansion Alignment 11	Build-out	2,700	ft	4	in	100	$ per lineal ft	$270,000	$415,000
P47	Pipeline	Expansion Alignment 11	Build-out	7,500	ft	6	in	110	$ per lineal ft	$825,000	$1,265,000
P48	Pipeline	Expansion Alignment 11	Build-out	10,400	ft	8	in	120	$ per lineal ft	$1,250,000	$1,915,000
P49	Pipeline	Expansion Alignment 11	Build-out	5,100	ft	12	in	150	$ per lineal ft	$765,000	$1,175,000
P50	Pipeline	Expansion Alignment 11	Build-out	29	meters			4,000	$ per meter	$120,000	$185,000
P51	Pipeline	Expansion Alignment 12	Build-out	500	ft	4	in	100	$ per lineal ft	$50,000	$80,000
P52	Pipeline	Expansion Alignment 12	Build-out	2,500	ft	6	in	110	$ per lineal ft	$275,000	$425,000
P53	Pipeline	Expansion Alignment 12	Build-out	5,100	ft	8	in	120	$ per lineal ft	$615,000	$945,000
P54	Pipeline	Expansion Alignment 12	Build-out	14	meters			4,000	$ per meter	$60,000	$95,000
P55	Pipeline	Expansion Alignment 13	Build-out	5,900	ft	8	in	120	$ per lineal ft	$710,000	$1,090,000
P56	Pipeline	Expansion Alignment 13	Build-out	8	meters			4,000	$ per meter	$35,000	$55,000
P57	Pipeline	Expansion Alignment 14	Phase III	1,400	ft	4	in	100	$ per lineal ft	$140,000	$215,000
P58	Pipeline	Expansion Alignment 14	Phase III	1,000	ft	6	in	110	$ per lineal ft	$110,000	$170,000

Table 10.4 Detailed Project List
Recycled Water Master Plan
Carlsbad Municipal Water District

P59	Pipeline	Expansion Alignment 14	Phase III	3,500	ft	8	in	120	$ per lineal ft	$420,000	$645,000
P60	Pipeline	Expansion Alignment 14	Phase III	6	meters			4,000	$ per meter	$25,000	$40,000
P61	Pipeline	Expansion Alignment 15	Phase III	1,000	ft	4	in	100	$ per lineal ft	$100,000	$155,000
P62	Pipeline	Expansion Alignment 15	Phase III	1,300	ft	6	in	110	$ per lineal ft	$145,000	$225,000
P63	Pipeline	Expansion Alignment 15	Phase III	9	meters			4,000	$ per meter	$40,000	$65,000
P64	Pipeline	Expansion Alignment 16	Build-out	1,400	ft	6	in	110	$ per lineal ft	$155,000	$240,000
P65	Pipeline	Expansion Alignment 16	Build-out	3	meters			4,000	$ per meter	$15,000	$25,000
P66	Pipeline	Expansion Alignment 17	Build-out	1,800	ft	4	in	100	$ per lineal ft	$180,000	$280,000
P67	Pipeline	Expansion Alignment 17	Build-out	13,200	ft	6	in	110	$ per lineal ft	$1,455,000	$2,230,000
P68	Pipeline	Expansion Alignment 17	Build-out	4,000	ft	8	in	120	$ per lineal ft	$480,000	$735,000
P69	Pipeline	Expansion Alignment 17	Build-out	26	meters			4,000	$ per meter	$105,000	$165,000
P70	Pipeline	Expansion Alignment 18	Build-out	4,700	ft	6	in	110	$ per lineal ft	$520,000	$800,000
P71	Pipeline	Expansion Alignment 18	Build-out	700	ft	8	in	120	$ per lineal ft	$85,000	$135,000
P72	Pipeline	Expansion Alignment 18	Build-out	17	meters			4,000	$ per meter	$70,000	$110,000
P73	Pipeline	Retrofit Customers near Existing System	Phase III	30	meters			4,000	$ per meter	$120,000	$185,000
P74	Pipeline	Redundancy Looping	Build-out	4,200	ft	12	in	150	$ per lineal ft	$630,000	$965,000
P75	Pipeline	Customers Near Existing System	Phase III	17	meters			4,000	$ per meter	$70,000	$110,000
P76	Storage	C Tank Chlorination and Mixing System	Existing							$75,000	$115,000
P77	Storage	Zone 384 Reservoir	Phase III	2.0	MG			1,500,000	$ per MG	$3,000,000	$4,590,000
P78	Pipeline	Pipeline to Santa Fe Tank I	Build-out	3,600	ft	12	in	150	$ per lineal ft	$540,000	$830,000
P79	Storage	Rehabilitate Santa Fe Tank I	Build-out	2.5	MG			1,500,000	$ per MG	$3,750,000	$5,740,000
P80	Treatment	Increase Capacity of Carlsbad WRF	Phase III	4.0	mgd				separate estimate	$5,490,000	$7,000,000
P81	Treatment	Increase Capacity of Carlsbad WRF	Build-out	3.0	mgd				separate estimate	$4,300,000	$5,500,000
									Total	$56,180,000	$83,680,000

As shown in Table 10.4, the total estimated construction cost of all identified projects is $56,180,000, and the corresponding capital cost with the additional markups and contingencies from Table 10.2 is $83,680,000.

While most projects listed in Table 10.4 are based on the unit costs presented in Table 10.3, separate estimates were developed for the increases in treatment plant capacity (Project ID P80 and P81) and are included in Appendix B. Additional lump sum costs were used for the connection to the failsafe pipeline (Project ID P16) and the C Tank Chlorination and Mixing System (Project ID P76).

For conservative planning purposes, unit costs for the rehabilitation of the Santa Fe Tank (Project ID P79) were assumed to be similar to new construction.

Project Phasing

Existing system recommendations, summarized in Chapter 8, are discussed separately as an existing phase. It is anticipated that these improvements would be implemented at the same time as Phase III. As discussed in Chapter 9, the system expansions are divided into two 10-year phases, Phase III and the Build-out Phase. The system expansions of the recommended system are described by phase below.

Existing: The existing system analysis consisted of one recommendation - a chlorination system for the C Tank. The capital cost for this recommendation is estimated as $0.1 M.

Phase III (2011-2020): Phase III includes the most feasible alignments as described in Chapter 9. This would expand CMWD’s recycled water system to the north area of Carlsbad and begin initial expansion into the neighboring agency through wholesale service to Shadowridge Golf Course. The overall system cost of these expansions is estimated at $32.3 M; and therefore would require a further increase in recycled water funds, either generated by rates and/or outside funding. It is assumed that the opportunities for funding would increase in the next decade to accommodate the increase in annual recycled water system expansion costs.

Build-out Phase (2021-2030): The Build-out Phase includes the expansion alignments not included in Phase III, as well as the backbone pipelines to the potential new developments with uncertain timing. The overall system cost of these build out expansions is estimated at $51.3 M, which is about double the cost of the Phase III expansion. Hence, a greater level of revenue generation from rates and outside funding would be required to implement these projects.

10.4 CAPITAL IMPROVEMENT PROGRAM

10.4.1 CIP by Planning Phase

As discussed previously, the CIP is divided into two phases. The first phase consists of the projects to be implemented as a part of the Phase III improvement program, while the second phase consists of the remaining projects anticipated through build-out of the recycled water system. Table 10.5 summarizes the breakdown of costs for each of the two phases (shown in million dollars).

Table 10.5 Capital Cost by Planning Phase and Project Type
Recycled Water Master Plan
Carlsbad Municipal Water District

Project Type	Existing	Phase III	Build-out Phase	Total
Pipelines	$0.0	$20.7	$40.1	$60.7
Treatment	$0.0	$7.0	$5.5	$12.5
Storage	$0.1	$4.6	$5.7	$10.4
Total	**$0.1**	**$32.3**	**$51.3**	**$83.7**

Note:
(1) Capital Costs are based on the cost assumptions discussed in Section 10.2. Detailed information for each project can be found in Table 10.4.

As shown in Table 10.5, the capital cost for Phase III is estimated at $32.3 M while the capital cost associated with the Build-out Phase is estimated at $51.3 M. Figure 10.1 presents the capital costs for each identified phase.

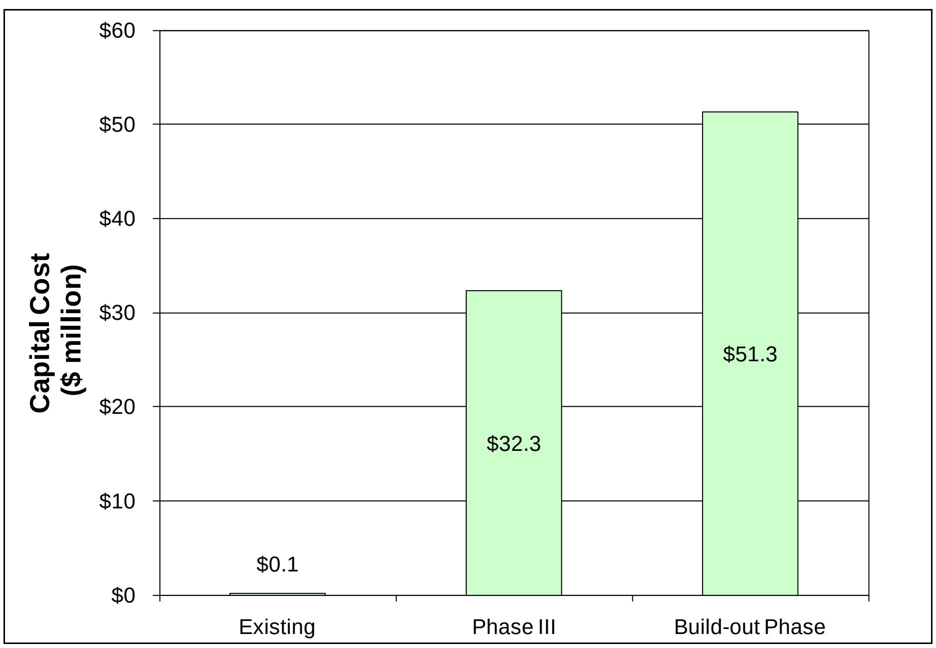

Figure 10.1 Capital Cost by Phase

The locations of the projects included in Phase III and the Build-out Phase are shown on Figure 10.2.

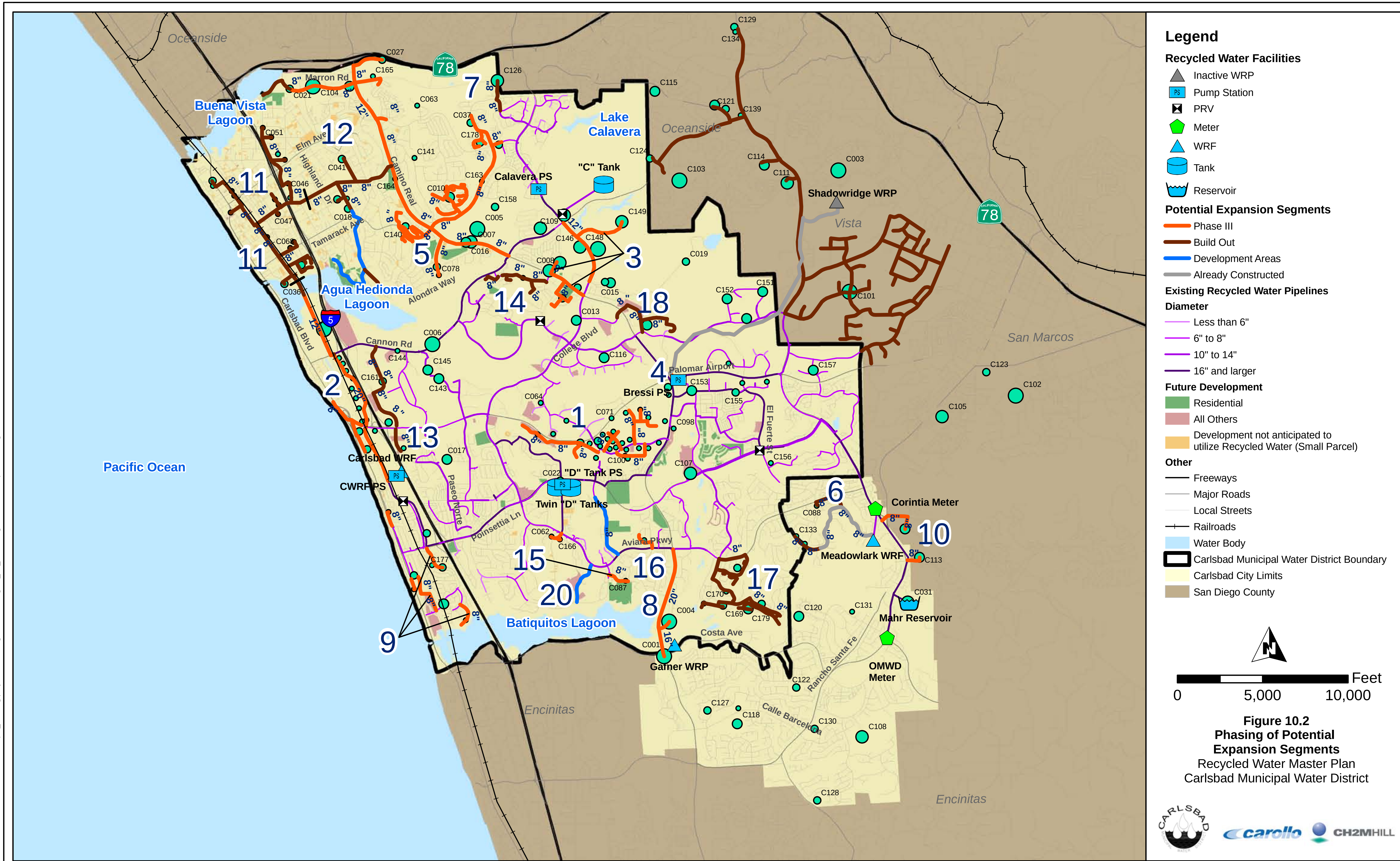

Figure 10.2
Phasing of Potential Expansion Segments
Recycled Water Master Plan
Carlsbad Municipal Water District

FILENAME: c:\pw_working\projectwise\lwang\d0102644\Figure_10_2-Phasing of Potential Expansion Segments.mxd

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10.4.2 CIP by Project Type

As shown in Table 10.5, pipelines represent the largest component of the total capital cost at about $61 M. Treatment and storage are similar in cost, at approximately $11 M and $10 M, respectively. Figure 10.3 presents the capital cost by project type graphically.

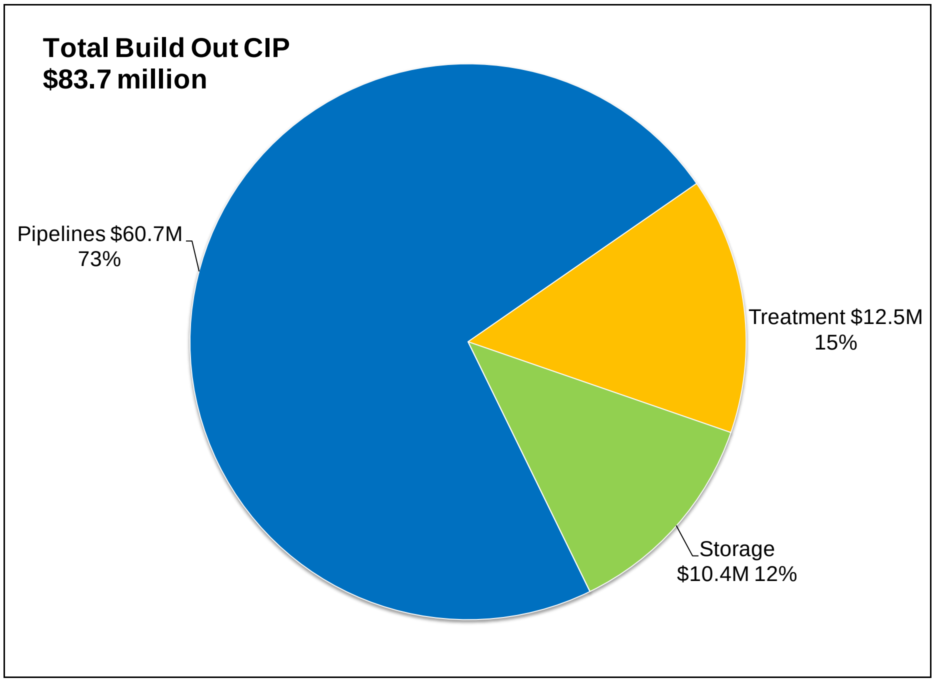

Figure 10.3 Capital Cost by Project Type

10.4.3 Escalated CIP

As discussed in Chapter 9, it is anticipated that completing the infrastructure to support Phase III will require approximately 5 years with an additional 5 years to connect all the customers to the distribution system. It is assumed that the Build-out Phase will follow a similar schedule. Based on this schedule, the approximate timeline for implementation of the two phases are shown in Table 10.6.

Table 10.6 Timeline of Phasing
Recycled Water Master Plan
Carlsbad Municipal Water District

Phase	Design and Construction of Infrastructure	Connection of Customers
Phase III	2011 – 2015	2015 – 2020
Build-out	2021 - 2025	2025 – 2030

The estimated escalated capital project costs are shown in Table 10.7. Cost escalation is calculated with a 3-percent inflation rate and uses the mid-year of each estimated phase of implementation. It is assumed that the existing system improvements would be incorporated into construction of Phase III. The mid-year of Phase III is 2013 while the mid-year of the Build-out Phase is 2023. A base year of 2010 was used to calculate cost escalation.

Table 10.7 Escalated CIP by Planning Phase
Recycled Water Master Plan
Carlsbad Municipal Water District

Phase	Capital Cost	Escalated Capital Cost
Existing	$0.1	$0.2
Phase III	$32.3	$35.3
Build-out	$51.3	$75.4
Total	**$83.7**	**$110.9**

Note:
(1) Calculation of escalated cost assumes a baseline year of 2010 and an inflation rate of 3 percent.

Figure 10.4 depicts the escalated capital cost as compared to the present day cost graphically.

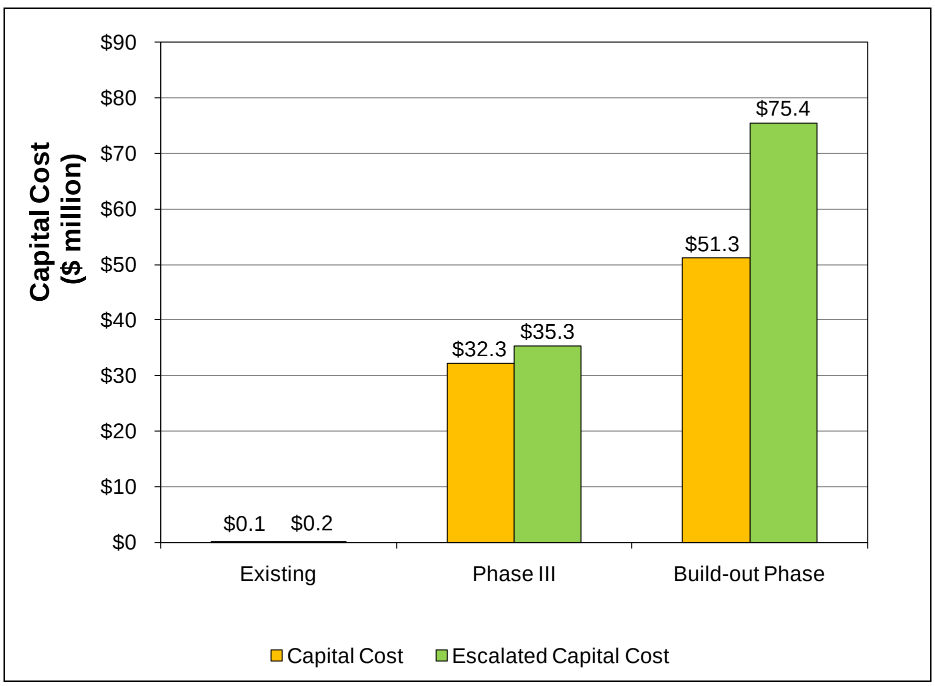

Figure 10.4 Escalated Capital Cost

As shown in Figure 10.4, the escalated capital cost figures more significantly into the Build-out Phase than Phase III. The anticipated unit cost of recycled water for each expansion phase is compared with the projected cost of imported water in Figure 10.5. As shown, the average unit cost for each phase is below the projected imported water costs for the same time period. Unit costs were calculated using annualized capital cost based on a depreciation period of 50 years and six (6) percent interest.

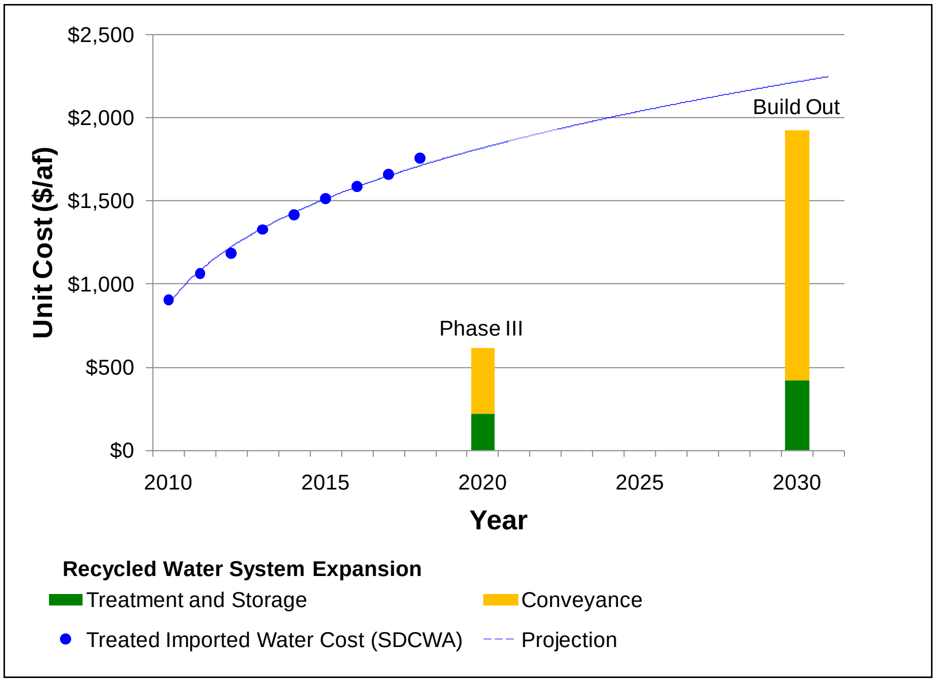

Figure 10.5 Comparison of Unit Costs to Imported Water

Based on the potable water cost curve presented in Figure 10.5, it can be concluded that the expansion of CMWD's recycled water system in both Phase III and through Build Out conditions is a cost-effective alternative to potable water supply. In addition to the cost benefit, recycled water provides increased supply reliability, especially during drought periods, and allows CMWD to remain more in control of the overall water supply cost for its customers.

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